VOL. 6

UNITED STATES OF AMERICA,
NORTHERN DISTRICT OF ILLINOIS, } ss.
EASTERN DIVISION.

IN THE

District Court of the United States

UNITED STATES OF AMERICA,
Complainant,
vs.
THE SANITARY DISTRICT OF CHICAGO,
Defendant,

C. C. No. 29,019 and Equity No. 114.

RECORD OF TESTIMONY AND PROOF TAKEN BEFORE COMMISSIONERS APPOINTED TO TAKE TESTIMONY IN SAID CAUSE.

Appearances:

MR. JAMES H. WILKERSON,
United States Attorney, and
MR. ALBERT L. HOPKINS,
Assistant United States Attorney,
For Complainant.

MR. EDMUND D. ADCOCK and
MR. ALFRED S. AUSTRIAN,
For Respondent.

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CHICAGO

VOL. 6.

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COMPLAINANT'S

Defendant's

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SUR-REBUTTAL EVIDENCE ON BEHALF OF THE DEFENDANT.

Depositions in the above entitled cause, taken pursuant to notice, before the Commissioner at the Federal Building, Chicago, Illinois, April 15, 1914, at 2 P. M.

Appearances:

Mr. Albert L. Hopkins, on behalf of the Government.

Mr. Edmund D. Adcock, and Mr. Alfred S. Austrian, on behalf of the Sanitary District.

DENNIS McCARDHY, a witness called on behalf of the Sanitary District, was first duly sworn by the Commissioner and testified as follows:

Direct Examination by Mr. Adcock.

Q. What is your full name?
A. Dennis McCardhy.
Q. Where do you reside?
A. Chicago.
Q. What is your business?
A. At present I ain't in any business.
Q. Have you been connected in any way with the Chicago River, with navigation on that river?
A. Yes, sir.
Q. Will you state what your connection has been; what you have done on the river and how long you have been familiar

with the conditions there, and with what concerns you have been connected.

A. Well, I have been on the Chicago River, connected with it for 40 years. Now, for about 10 years, I was engineer on a dredge; for 30 years superintendent for different companies, working on the Chicago River dredging and docking and so on, etc.

Q. Have you been on towing crafts?

A. Well, I have superintended, that is having charge of the tugs towing crafts.

Q. In your occupation, you were brought in direct contact with the river, were you?

A. Yes, sir.

Q. During the navigation season about how many times during the day would you travel or navigate, go up and down the Chicago River?

A. Oh, sometimes once, sometimes five times, four or five times.

Q. For what space of years; how long did that continue?

A. Well, for 30 years.

Q. And when did you stop, along about the year 1912, was it?

A. That I resigned?

Q. Yes?

A. Yes, in 1912.

Q. Now, you were connected with the Chicago Towing & Dredge Company, were you for a time, dredging and towing company?

A. I was connected with the Chicago Dredging & Dock Company, the Lydon & Drew Company, and the Chicago Great Lakes Dredging Company.

Q. During what period were you connected with the company that you first named?

A. Well, it was in the eighties; I just don't recollect.

Q. Up until about the year 1896, was it?

A. Along about that, yes.

Q. Do you know about what year in the eighties it was?

A. Sir?

Q. Do you know about what year in the eighties you became connected with the Chicago Dredging & Dock Company?

A. Well, it might have been 1880 or 1881, or somewheres along there. I could not recollect the dates exactly.

Q. Were you superintendent then of their work?

A. Not when I first went to work for them. I was engineer of a dredge. About 1881 or '82, I became superintendent.

Q. What did their work consist of principally?

A. Dredging, docking, piledriving and foundations, bridge foundations and so on.

Q. And towing?

A. Towing their own—doing their own towing, such as mud scows, dredges, piledrivers and so forth.

Q. And your duties as superintendent made it necessary for you to traverse the Chicago River and its branches at different times during the navigation season, and each day?

A. Yes, sir.

Q. And you were familiar with the conditions of navigation upon the Chicago River?

A. Yes, sir.

Q. During that period?

A. Yes, sir.

Q. From 1896 until what time were you connected with the Lydon & Drew Company, or the Great Lakes Dredging & Dock Company?

A. Well, from 1896 until 1912.

Q. You were superintendent for them, were you?

A. Yes, sir.

Q. Of their work. Did they have anything to do with work upon the Chicago River itself, and its branches?

A. Yes, sir.

Q. Just state in general what work you did during that period?

A. Well, their work consisted of deepening and widening the river, docking, dredging; building piers for breakwaters, bridge foundations and so on, etc.

Q. And while you were superintendent for Lydon & Drew, or the Great Lakes Dredging & Dock Company, both, did you become familiar with the navigation conditions during that period on the Chicago River?

A. Yes, sir.

Q. And you traversed the Chicago River and its branches in the same way that you did before, did you?

A. Yes, sir.

Q. In your work for these various companies, was it necessary for you to tow scows up and down the river?

A. Yes, sir.

Q. Prior to 1900, what was the capacity of the scows that were usually towed?

A. Well, from 150 yards up to 180 yards.

Q. In recent years you have had larger scows, have you not?

A. Yes.

Q. What capacity are they?

A. Well, from 750 to 1,000 yards.

Q. You have had occasion to tow those scows, scows of that capacity, have you not?

A. Yes, sir.

Q. During what period was it that you towed the larger scows?

A. Well, let me see: I would say offhand the last six or seven years, seven or eight years; six, seven or eight years.

Q. When you speak of capacity, you mean that is the capacity of the scows carrying the mud or other material, cubic yards?

A. That was the yards, yes, sir, yardage.

Q. How were those scows towed; was there just one or two?

A. No, we could tow one to three. We have towed three.

Q. They were fastened together, one following another?

A. Yes.

Q. And they had a tug in front?

A. Yes, sir.

Q. And the motive power was steam?

A. Steam tugs.

Q. On the tugs. No motive power on the scows?

A. Not at all.

Q. How about the steering, as compared with boats that are towed in the Chicago River?

A. There is no steering of a scow. The tug has to control the—

Q. In your opinion is it more difficult to tow scows than an ordinary boat that is towed on the river?

A. Yes.

Q. Under those conditions?

A. Yes, I think it is more difficult.

Q. If there is difficulty in navigation, it would be more apparent in towing the scows that way than towing boats?

A. I would say it is more difficult to tow the scows, on account of no steering apparatus.

Q. And because they have no motive power of their own?

A. No motive power of their own.

Q. What has been the condition of the Chicago River since 1900, or since the work done by the Sanitary District in the deepening and widening of the Chicago River was commenced, and has been practically completed, with reference to navigation, as compared with the condition which existed prior to that time?

A. Well, now, you know that is a question that when we started, we did not improve the conditions; it took several years to go along and make—improve those conditions.

Q. The question I intended to ask you is this: Since the work has been practically completed?

A. Yes.

Q. The deepening and widening the river. As I understand it, Mr. McCardhy, before the Sanitary District commenced its work the Chicago River, the depth was about 16 feet, and they have deepened it now to approximately 26 feet. Is that correct?

A. Yes, that is correct; from 14 to 16 feet is the depth of the Chicago River.

Q. And the Chicago River has also been widened by the Sanitary District to approximately 200 feet at all points except points, certain places now under improvement, is that correct?

A. Yes. The United States Government also worked in widening the river some places.

Q. At the same time that the Sanitary District did, in conjunction with that work?

A. Yes.

Q. And the Sanitary District has put in or replaced a number of bridges with bridges having wider bridge openings, have they not?

A. Yes. In other words, they have taken away the center piers in a great number of bridges.

Q. Having those things in mind, how is the condition of the Chicago River, the main river, the South Branch and the West Fork to the beginning of the Drainage Canal, with reference to navigation, how does it compare now with the conditions which existed prior to the doing of that work which you have mentioned?

A. Well, I would say they are far better to-day. There is some improvements to be made yet, as I understand, that they are about starting at now. The Chicago River today, and has been for the last year, south of 12th street, south of 12th street with the exception of two railroad bridges which they are about taking out, why you could not improve it any more than it is.

Q. Do you consider that these particular improvements that have been made and that are now being made at the bridges, taking those improvements into consideration, do you consider that the conditions of navigation there will be good?

A. I do. I think they will be very good.

Q. You refer, do you not, Mr. McCardhy, to the Van Buren street bridge situation?

A. Yes.

Q. To the Jackson street bridge?

A. Yes.

Q. When you speak of the Van Buren street bridge, that is the Metropolitan and the city bridge there; there are two bridges there?

A. Yes.

Q. And the Madison street bridge?

A. The Madison street bridge.

Q. That is under improvement. The 12th street bridge?

A. Yes.

Q. The Pennsylvania bridge which has been ordered out?

A. Yes.

Mr. Hopkins: I think the witness ought to do the testifying. I object to leading questions.

Q. And the 16th street bridge, the Air Line bridge?

A. Yes.

Q. Which has been ordered out as you understand it, Mr. McCardhy?

Mr. Hopkins: I object to the question as leading.

A. The greater part of this is under way now. The greater part of this improvement is under way now.

Q. When the improvements referred to, now under construction, are made, what in your opinion will be the condition of navigation upon the Chicago River, the South Branch and the West Fork to the Drainage Canal?

A. Well, I would consider it a very navigable stream, the river, very easy to navigate.

Q. How will that condition compare with the conditions with reference to navigation that existed prior to the opening of the canal and the making of these improvements?

A. The conditions of these improvements made, and the condition of the river previous to when these improvements were started would be 500 per cent. ahead of what was there when they were started.

Q. Mr. McCardhy, the Government introduced some witnesses here last week, showing that there was a considerable current at certain points in the river. Have you come in contact with those points?

A. Yes, I have.

Q. What points?

A. Washington street.

Q. Did you have occasion to pass that spot frequently?

A. Yes.

Q. While there was a current?

A. Yes.

Q. What occasioned that current, if you know?

A. Well, they were putting in new foundations for the bridge and they had cofferdams in on each side of the bridge

which narrowed the stream up so much that it caused this current. Instead of the water passing through a 200-foot channel it was passing through a 100-foot channel, so it must have caused the current.

Q. That was merely a temporary blockade?

A. Yes, during the time of construction of the bridge.

Q. That has since been removed, has it not?

A. Oh, yes, that is removed.

Q. Has that current you refer to, disappeared?

A. The current has disappeared.

Q. What other, if any, points have you observed where there was a strong current at different times?

A. Well, at the Pennsylvania Railroad bridge.

Q. What was that occasioned by, if you know?

A. By the new construction they were putting in for the new bridge. They narrowed the channel up there with the piers, abutments.

Q. That was necessary for the purpose of making the improvements?

A. Oh, yes, it was necessary.

Q. Do you know who ordered that improvement?

A. Well, I don't know whether it was ordered by the United States Government or the Sanitary District, I don't know who it was ordered by.

Q. When that obstruction and those cofferdams are removed, which are necessary to rehabilitate or reconstruct that bridge, in your opinion that current will be removed?

A. Oh, there is no doubt about it.

Q. Any other spot you noticed that was particularly dangerous to navigation at any other time?

A. Well, there is another bad spot at, I guess at Congress street where that power house stands.

Q. That is under condemnation now as you understand it?

A. Well, I don't know.

Q. Immediately north and south of that power house, the river is 200 feet wide, isn't it?

A. Yes—well, it has been widened. I just don't know what width it is.

Q. The record in this case shows it is over 200 feet wide?

A. Yes.

Q. When that is removed, the obstruction occasioned by that power house, this current that you refer to will likewise be eradicated, will it not?

A. Yes.

Q. Have you observed the improvements made by the

Sanitary District with reference to straightening out any parts of the river?

A. Yes, sir.

Q. For instance, Mr. McCardhy, I draw your attention to a blueprint which on its face indicates: Map shown to Witness Green, number 2; particularly that part of the blueprint between 22nd street and Halsted street?

A. Yes.

Q. Will you state in what way the Sanitary District has caused the river to be improved for the benefit of navigation at those points between the two lines indicated, Halsted and 22nd street?

A. They cut off this pocket (indicating) and widened out the river there.

Q. They cut off the property from Dupont's Slip on the west side of the river to the lot marked 6 adjacent to the words "Lumber street"?

A. Yes.

Q. Do you know how much they took off at the widest part there?

A. Well, my recollection would say in the neighborhood of 100 feet there on the widest part.

Q. It tapered down as indicated on that plat?

A. The Sanitary District done some work there and also the United States Government.

Q. They worked in conjunction there, did they not?

A. Yes, they done some work.

Q. I draw your attention to the south bank, south and east bank of the river, mostly east, from Ogden Slip to 22nd street?

A. Yes.

Q. They likewise took out a great quantity of earth there, did they not?

A. Yes.

Q. Do you recall how much they took out?

A. I do not. I don't remember how much was taken out.

Q. It was a very large quantity?

A. It was, of course there was one wider place.

Q. Did they deepen the river from Halsted street to 22nd where that improvement was made?

A. Yes, sir.

Q. What effect did the improvements I have just referred to make on the navigability of the stream between Halsted street and 22nd street?

A. Well, it made easier navigation to commence with, and it done away with accidents that happened along there on account of this narrow river.

Q. What did they call the river between Halsted street and 22nd street prior to this improvement made by the Sanitary District?

A. The name that marine men called it and river men called it was "Collision Bend."

Q. I have drawn your attention not to those two improvements. There were many other improvements made by the Sanitary District of the same character?

A. Yes, sir.

Q. Along the river, were there not?

A. Yes, sir.

Q. Were you familiar in your travels with the question of the occurrence of accidents and collisions in the river prior to these improvements by the Sanitary District?

A. Yes, sir.

Q. Were there a great number of collisions, a large number of collisions occurring prior to that time?

A. Yes, sir, there was a great many collisions.

Q. What was the general character of the collisions that occurred in the river before it was widened, before it was deepened and before it was improved by the removal of center pier bridges?

A. Well, away back in those times before this was improved—

Q. By "this," you mean from Halsted street to 22nd street?

A. Yes. I judge that 80 per cent. of the boats passing through there at that time was sail vessels towed by tugs. Of course, they are gone up, and there ain't very many sail vessels towed by tugs any more, but at that time you would hear of 20 collisions such as vessels colliding and their jibbooms taken away, where you would not hear of one or two in a season, I don't believe you would hear of one in a season now. That was a common occurrence every day or two to hear of those collisions.

Q. Mr. McCardhy, in your travels up and down the river and working in and about the river between 1900 and 1912, or in the later years of the period 1900 to 1912, were collisions and accidents on the Chicago River greater in number than they were before, or less in number?

A. They were less in number.

Q. Was the Chicago River in your opinion and is the

Chicago River and the South Branch and the West Fork of the South Branch in 1912, and up to the present time easier of navigation than it was prior to the turning of the river, and prior to the making of the improvements that you have referred to?

Mr. Hopkins: All this examination about the comparative navigability of the river will be objected to.

Mr. Austrian: I will state for the benefit of the record that the objection, in my humble opinion, comes with poor grace from the counsel on the other side who introduced it into the record on the last hearing of the testimony in this case.

The Witness: Do you want me to answer that yes or no?

Mr. Adcock: Yes.

A. I say that south of 12th street, principally south of 12th street, navigation is far easier than it was those days. Now, there is several improvements to be made north of 12th street for to make the—

Q. North of 12th street it is easier than south of 12th street?

A. South of 12th street it is finished, that is completed except those two railroad bridges.

Q. Under process of reconstruction?

A. Yes. North of 12th street, there is several of them bad points to come out yet.

Q. And they are under improvement at the present time?

A. Well, that is what I understand. I don't know that.

Q. You haven't been down to look at it?

A. No.

Q. When those critical points that you have referred to are improved by the construction of new bridges and the removal of center pier bridges and the other improvements that you have referred to are made north of 12th street, how in your opinion will the Chicago River compare with reference to navigation in its present state as compared to its state prior to the making of these improvements by the Sanitary District, taking into account, if you please, Mr. McCardhy, the fact that the Chicago River is flowing away from the lake now, while prior to the making of these improvements it was flowing into the lake?

A. Well, I would say the improvements carried on north of 12th street as they have been carried on south of 12 street, that navigation would be 500 per cent. easier in these conditions than it would prior to 1900.

Q. And in making that statement Mr. McCardhy, have you

taken into consideration and account the fact that the vessels to-day are much larger and of greater tonnage, length and beam, than they were when this improvement was initially started?

A. Oh yes, I have, because we have followed that up ourselves in our own business. We have increased our scows and dredges and so on in size; and tugs.

Q. Nearly five times, have you not?

A. Yes.

Q. How did the navigation with these large scows in later years compare with the navigation of the smaller scows in former years? Is it harder or easier?

A. They are easier except I say at these bad spots.

Q. Where it is being improved?

A. Yes.

Q. In your experience in operating on the river, did you have occasion to come in contact with freshets or flood conditions prior to the reversal of the flow of the Chicago River?

A. Yes, sir.

Q. Will you state what those conditions were and what effect if any they had on navigation?

A. Well, there is one in particular that I recollect, and I could not exactly state the date of that. But my experience was this: That I was building a dock for the S. K. Martin Lumber Company on the Northwestern Railroad Company in Mud Lake, and I had pile drivers there, of course, working at it, and Saturday night we tied up for over Sunday, and Sunday I was called up and the water had raised in the neighborhood of seven feet, and my pile driver was up in the lumber yard. Now the dock was about 4 feet over water, well it took from 3 to 3 1/3 to float the pile driver. The water had raised that much, she had got up over the dock, floated up over the dock. It didn't last over maybe three days, two or three days, something like that. But the date of that I do not recollect now. It might have been—I don't know just what date it was.

Q. The evidence previously taken in this case shows it was in 1892 or 1893.

A. I could not say offhand the date.

Q. Mr. McCardhy, this place that you speak of, was that on the Chicago River?

A. It was on the Chicago River, yes.

Q. What were the freshet conditions, the water conditions that frequently occurred in the spring?

A. Every spring we had a freshet. I think this one I speak of was the worst one we had, but it was a common thing to

have the water raise three or four feet in the spring of the year.

Q. Did that create a current?

A. Oh my, yes, it was a regular—

Q. Did it have any effect on navigation?

A. They could not navigate, too costly.

Q. Since the opening of the Sanitary Canal and the making of these improvements, do you know of any such conditions existing?

A. No.

Cross-Examination by Mr. Hopkins.

Q. During your business experience you have been superintendent for these various companies you have mentioned?

A. For about 30 years.

Q. You are not a navigator as such are you?

A. No.

Q. You have no license as a commander of a vessel, anything of that kind?

A. No.

Q. You have never done any practical sailing yourself?

A. Oh I have, yes.

Q. What?

A. Well, I have often steered a tug up and down the river, but I am not a licensed man, don't you know.

Q. Now these scows that you have been using in recent years, your big ones, how long are they?

A. Well, from 125 to 135 feet long.

Q. How wide?

A. 40 and 41 feet; from 38 to 41 feet.

Q. What is the depth?

A. 12 feet.

Q. What draft do they carry, 12 feet?

A. They are about 12 feet draft, about 12 1/2 foot sides. We load them right down, decks too. We often have them draw 12 feet loaded.

Q. Now you say that a tug draws from 1 to sometimes 3?

A. Yes, we have had 3 on. 2 is about the average but we often have had 3.

Q. Have you had 3 loaded, carrying them against the current?

A. Yes, sir.

Q. What time of the day and when have you done that?

A. Well, the city passed a law here some years ago that we

could not carry—we should not tow 3 and since that we had to stop it. We were forced to.

Q. When was that passed?

A. It might be two years ago. The city won't allow us to tow three scows in one tow now.

Q. Two years ago?

A. Something like that, it might be two, but the city passed that law.

Q. Now so far as current is concerned, does it make much difference whether you tow one or two scows? Doesn't the first one break the force of the current?

A. The first one of course, the current from the tug wheel hits the first one, and also what other little current there is.

Q. What investigation have you personally made as to the depth of the Chicago River in recent years?

A. I have had the superintending of the dredging of it.

Q. You wish to state in this record that there is a depth of 26 feet all along that river?

A. I would not say that there is all along; there may be spots there is not. But our contract with the Sanitary District called for 26 feet of water. Now they had an inspector on there and if we did not get the 26 feet, we were notified that there was not 26 feet. Now, where the tunnels is, of course that is only in the latter two or three years when Van Buren street tunnel was lowered. Up to that time there was only, I think, 17 feet of water over Van Buren street tunnel, or somethink like that. Now there is 27 feet on top of the tunnel.

Q. Some of this dredging was done quite a long time ago, wasn't it?

A. No, there was some of it done in the last two or three years.

Q. I know, but some of it was done quite a long time ago, wasn't it?

A. Yes.

Q. Do you undertake to go the full length of the river every year?

A. No.

Q. So that some of those parts that was 26 feet eight, nine, or ten years ago, may have been much filled up since?

A. The river don't go eight or ten years without dredging. It is dredged oftener than that, but it is not dredged every year.

Q. In connection with your work, there is nothing that you do to check up on the depth every year. You really don't

know unless it is some particular place you happen to be working at?

A. The Sanitary District or the Governwment, or whoever it might be, gives us orders with specifications. Now it is my duty to instruct the men aboard that dredge what to do, whether to take 20 feet or 26, or whatever it is. That is what I always did.

Q. That is when you did the work?

A. Yes.

Q. After that, after you finished your job you don't know how much it has filled up?

A. No, did not care.

Q. Did you do the dredging for the width?

A. Yes, sir—well, maybe not in all cases, but the majority of places I done the dredging for the width.

Q. Aren't there a great many places along the length of that river where the width is less than 200 feet?

A. I could not say offhand to that. The width I would not say offhand what it is.

Q. You mentioned the Washington street place. What is the width there now since they have completed their work?

A. I don't know.

Q. What is the width at the Metropolitan Bridge?

A. I don't know.

Q. Is that the place where there is a by-pass around under the Pennsylvania Station?

A. Yes.

Q. Do you know anything about the current or the conditions in that by-pass?

A. I don't know how much current there was. I knew water passed through there.

Mr. Austrian: Through the by-pass?

A. Yes, but I don't know what current there was there.

Mr. Hopkins: Q. How long has it been since that by-pass was dug there?

A. Oh, I don't know. It might be nine or ten years ago. I don't know just when it was.

Q. That is covered over isn't it with a platform?

A. Yes.

Q. So that since it was dug, there has been no dredging whatever in that?

A. No.

Q. And the part of the river that is open there is less than 100 feet, isn't it?

A. The width I don't know. The width I don't know.

Q. So that you don't know what the width of the river is?

A. No, I don't.

Mr. Adcock: Mr. Hopkins, you understand that the Metropolitan Bridge has been ordered out by the United States Government. They have been directed to put in a wider bridge, a bridge with wider openings. Do you want us to produce the order of the Secretary of War, ordering that out?

Mr. Hopkins: No. If you want that fact in the record I am willing to admit it.

Mr. Adcock: Willing to admit it has been ordered out by the Secretary of War?

Mr. Hopkins: Yes.

Mr. Austrian: We are going to put a witness on to show all those things.

Mr. Hopkins: I don't know what the conditions are.

Q. I believe you said that you of your own knowledge don't know just what part of the river is under improvement and what is intended to be improved?

A. No, only what I hear. What I hear may not always be true.

Q. You spoke of some collisions in Collision Bend down there, and it is not so bad as it used to be in that place. At that time, they were mostly sailing vessels, weren't they?

A. Mostly—well, I would say 80 per cent. pretty near of the boats that passed there was sailing vessels towed by tugs.

Q. And down there in the river the tug had to do all the controlling, didn't it?

A. Yes.

Mr. Adcock: Q. They had steering—

Mr. Hopkins: Q. You had a great many vessels—

Mr. Adcock: Q. They had steering apparatus on the sailing vessels, didn't they, Mr. McCarhdy?

A. Let me understand the equestion there.

Mr. Hopkins: Which question?

A. The last question.

Q. I said they had a great many more vessels in the river at that time, didn't they?

A. Yes. I say that 80 per cent. of them was vessels, sailing vessels.

Q. I mean of any kind or shape, you had more ships in there?

A. More ships in there, yes.

Q. Whether sailing or steam or not?
A. Yes.
Q. As a matter of fact, there was more tonnage in the river then than now?
A. No, I would not say more tonnage.
Q. Do you know whether there is more or less since 1900?
A. I understand there is more tonnage now, in the river, than there was those days, but not the number of boats.
Q. Would it make any difference if you knew that there was less tonnage?
A. No, it would not make any difference but I say that was my understanding.
Mr. Adcock: Q. These sailing vessels of course had steering apparatus, didn't they?
A. Oh yes, yes.
Mr. Hopkins: Q. They also had long booms sticking out?
A. Yes.
Q. Things of that kind?
A. Yes.
Q. What was the nature of the accidents?
A. The river was very narrow, and it was not only narrow but it was going around a bend like this (illustrating) and if two boats met in that narrow places, some of them was going to collide. Now there was, for a long time, the boat coming this way (indicating), or the boat going this way (indicating), meet in that bend, whichever was the furthest away would have to stop until this boat got through. And we have had to stop thousands and thousands of times waiting for some boat to get through, running there with our scows.
Mr. Adcock: Q. That was before 1900?
A. I am talking of that now. I understand he is, Mr. Hopkins is.
Mr. Hopkins: Q. That was because of the narrowness of the river, was it?
A. Narrowness and the crookedness, both combined.
Q. Prior to the opening of the Drainage Canal, you speak of freshets, spring freshets. About how long did they last to an extent that they prevented navigation?
A. Well, I would say offhand from—oh, from three to four days, maybe five days.
Q. What month did they occur in Mr. McCardhy?
A. Well, as a rule it was in the latter part of March or April; it was in April; fore part of April.
Q. Before the season of navigation?

A. Before the season of navigation, yes.

Q. What current would there be in the river at that time which would interrupt navigation?

A. Oh really I could not say offhand how many miles.

Q. No way of estimating the miles per hour?

A. No, I could not say that.

Mr. Hopkins: That is all.

Re-direct Examination by Mr. Adcock.

Q. That freshets that you have spoken of occurred in May or June didn't it, that big one?

A. I could not recollect that. As a rule the freshets would occur in the last of March or April, as the snow and ice would melt out. If it was in May or June I could not say.

Q. That big freshet you speak of, that occurred during the navigation season did it not Mr. McCardhy, where the boats were torn away from their moorings?

A. Yes, but I could not say offhand now whether it was before navigation or whether navigation was opened. Of course boats tied to the dock, vessels laying over winter, would break their moorings and go adrift; but I can't say whether it was after navigation or not that the big freshet occurred.

GEORGE M. WISNER, a witness recalled in sur-rebuttal on behalf of the Defendant, having been previously sworn, testified as follows:

Direct Examination by Mr. Adcock.

Q. Mr. Wisner, you testified in your former examination with reference to the time that it would take to establish a flow of 10,000 cubic feet per second, assuming that the flow had formerly been 4167 throughout the channel. That is when I say 10,000 cubic feet, I mean uniform flow through the channel and the Chicago River. And it is my recollection you stated it would take from seven to nine hours to accomplish that change. Have you any further information, have you made any investigation since then which you wish to state in further explanation of your answer to that question?

A. Yes, sir.

Q. State what information you have, and what investigations you have made?

A. I was testifying at that time from my recollection as to how long after the controlling works at Lockport were changed from one elevation to another you would see the effect in the Chicago River. This was occasioned usually by vessels being caught upon one of the tunnels in the river, and we would shut off the water so as to raise it, and release the vessels from the tunnels.

Q. That is raise the water surface?

A. Raise the water surface at Washington Street or La Salle Street; principally at Washington Street where most of the trouble was occasioned.

Q. When were those tunnels taken out?

A. Four or five or six years ago. My recollection was it would be from seven to nine hours after we changed the flow before the vessel could get off; and sometimes it was a little longer. I had made no measurements, discharge measurements, nor had I made any gage readings, that I remember of, along the channel; but simply by observing at the place where the vessel was aground. And my recollection was, as I stated, this was seven to nine hours. The only thing that we had to gage whether the water elevation changed was watching the boat as it was released from the tunnel and then afterwards when we turned the water on observing by the eye how long it was before the current started up again.

Since testifying previously, I have had two different tests made, one on February 22 and the other on March 8, to determine how much the discharge in the main channel and the Chicago River would change when the discharge at the Controlling Works was increased from approximately 4,000 cubic feet per second to 10,000 cubic feet per second.

Q. That is you established a flow for how long at 4167 cubic feet per second?

A. For the 12 hours preceding, that is approximately 12 hours.

Mr. Wilkerson: Just a moment: Do you think you have made that testimony competent? I do not want to be capitious in my objections, but I doubt whether under any rule that is competent.

Mr. Adcock: What do you mean?

Mr. Wilkerson: That is against the hearsay rule. He has not told how it was made.

Mr. Adcock: He is going to explain it in detail. You can have all the field notes and everything you want, or we will put them in.

Mr. Wilkerson: He was going ahead with conclusions.

Mr. Adcock: Yes.

Mr. Wilkerson: Without having given us—

Mr. Adcock: I understand he will state how the test was carried out and by whom. Also in connection with these tests he will submit for the examination of the Government the notes of the engineers who made the tests, or if you insist we can call the witnesses and have them testify concerning what they did, whichever way is satisfactory to the Government.

The Witness: For the 12 hours preceding the time at which the flow was changed from approximately 4,000 cubic feet to 10,000 cubic feet per second, we tried to adjust the flow of the canal so as to have as near as possible a uniform flow of 4,000 cubic feet through the channel. That is we reduced the flow somewhat from the amount we had been flowing.

Q. That was at the Controlling Works?

A. At the Controlling Works at Lockport.

Q. For how long a period did you maintain that flow of 4167 cubic feet?

A. For a little over six hours we had it going through the channel, on February 22nd.

Q. Go ahead and state just what you did in connection with that, what was done, Mr. Wisner?

A. And on March 8th, it was practically the same.

On the 22nd, the work was done under my direction, with Mr. Murray Blanchard in direct charge of the field operations. This is the same Mr. Blanchard who has been mentioned in the testimony as having been connected with the Lake Survey in the discharge measurements of the St. Marys River and the St. Clair River; and had charge, as I understand it, of the measurements for the Lake Survey on the Detroit River. He was in direct charge of the work. In addition, there were several engineers and helpers from this office. And we measured the water as near as we could at the Controlling Works by means of the dam, and the amount we thought was going through the power wheels; and then we had a current meter measurement at Lemont, Summit and Dearborn Street; the gages being read at those places.

Q. When you say you measured as near as you could the volume of water that was going through the Controlling Works, how closely did you ascertain that amount?

A. I imagine that we were within—outside limits—within 10 per cent. of it one way or the other. That is not a very definite quantity.

The section at Lemont was the same section as was measured by Mr. Moore of the Lake Survey, a section that we had been carrying on measurements at for some time. The method pursued was the same as that used by the Lake Survey, as I understand it. That is verticals were determined, and the meter immersed at one point and the coefficient determined for that particular point.

Q. On February 22, and 23, from six P. M. until about 5:30 A. M., we flowed as near as it was possible 10,000 cubic feet through the Controlling Works and measured the water, as I stated, at the other places by means of current meters. The gaged were also read.

The flow was increased at about 5:53 to about 6:10; took that long to increase the flow, manipulate the works; that is P. M. on February 22. And then we attempted to keep up as near 10,000 as we could. Generally, I would say throughout that time the flow according to the power house measurements probably averaged 200 cubic feet over 10,000.

The computations were worked up of the discharge at Lemont and at Summit and Dearborn Street.

The section at Summit was about four or five miles above Willow Springs. The discharge measurement at Lemont was taken by means of a Haskell Current Meter; at Summit we used the Price Meter; and at Dearborn Street a Haskell Meter. We only had those three meters available at that time.

I would have run this test longer but it was absolutely impossible to do it without absolutely breaking a lot of contracts that we had for the furnishing of power, and I could not run it at that time any longer than the 12 hours approximately, as testified to.

Q. What flow did you get at different times at the various sections which you have mentioned, on February 22?

A. The largest flow that we were able to get at Lemont was 9300 cubic feet per second.

Q. That is within that time?

A. Within that time, yes; within the whole time between six o'clock P. M. of February 22, and 5:30 of the next morning.

Q. And when did that maximum flow appear at Lemont?

A. There is a peculiar thing that seems to happen when this flow is turned on: There will be an indication of a large flow at Lemont about an hour and a half to an hour and 50 minutes after the flow was increased at Lockport.

Q. How far is Lemont from Lockport?

A. It is eight miles from the old Controlling Works in

round figures, and ten miles from the power house. That flow only keeps up for a very short time, and it drops off as though there were possibly an influence, an impulse set up in the water; and the water only being measured at one particular point, I am of the opinion you get a false indication of the discharge at that time, because the flow then did not go up again until about 3:30 the next morning.

Mr. Wilkerson: Q. What was that maximum?

A. 9300 Cubic feet per second.

Q. That is the figure for an hour and a half after the works were opened at Lockport?

A. That was an hour and a half afterwards. Then it dropped off to about 8200 cubic feet per second.

Mr. Adcock: Q. At what time?

A. It reached that at ten o'clock at night, when it raised gradually to 9300 and some odd cubic feet per second at 3:30 the following morning.

Q. That is you had 9300 flow twice?

A. So indicated by the meter, yes.

Q. And the first was at what hour?

A. About 7:30.

Q. About an hour and a half after—

A. We started to turn it on at about 5:50.

Q. You say it took until about 6:10 to fully change the works so that you had a flow of approximately 10,000 cubic feet?

A. Yes. That is the reason I answered it took an hour and a half to an hour and 50 minutes.

Q. Then it went down to about 8,000 cubic feet per second at about what time?

A. Between 9:30 and 10 o'clock that night.

Q. Then gradually rose?

A. To 9300 feet at about 3:30 the following morning.

Q. How long did it remain at 9300 cubic feet per second?

A. It was pretty close then to the end of the time we took in making the test, and my recollection is the meter got off at that time.

Mr. Wilkerson: Was the 8200 the lowest flow reported after the 9300?

A. That is the lowest flow.

Mr. Adcock: Q. It gradually fell to the 8200 is that correct?

A. Yes. At Summit, the first indication of the increase in the discharge came at seven o'clock, and it gradually rose so that at eight o'clock there was a flow of 7,000 cubic feet.

There was a gradual rise of the discharge at Summit then until about one thirty, when the flow reached 8200 cubic feet. From then until the end of the test, at about six o'clock the next morning, the flow ran practically 8,000 cubic feet.

Q. How far is Summit from the section that you previously mentioned?

A. It is 13 miles. It is about four or five miles above Willow Springs; that is about 12 or 13 miles above Lemont.

Mr. Hopkins: Making about 20 miles from Lockport, 22 miles?

A. 22 miles from the power house.

Q. The regulation was done at the power house?

A. Yes, that is the only place that we can regulate the flow.

Mr. Wilkerson: What is the maximum amount you can let through there, 14,000?

A. You can let that through for a short space, and then you pull it down so that you are not able to get it through there on account of the contraction of the channel above.

Mr. Adcock: That is in the earth section?

A. The earth section, and the Chicago River itself.

The measurements at Dearborn Street were carried on, as I stated, by a Haskell Meter and the flow had an increase, starting in about 8:30 that night, began to slowly increase and raised gradually to about 2:30 in the morning when there was a flow of about 5800 cubic feet per second.

It then gradually decreased to five o'clock in the morning when there was an indicated flow of 5500 cubic feet per second; and from five o'clock in the morning until six in the morning it increased, so that at that time there was approximately 6200 cubic feet per second passing Dearborn Street.

I would say in this connection that Dearborn Street being so close to the lake, it is influenced by the rise and fall of the lake.

Q. What was the condition of the Chicago gage at that time with reference to the rise and fall of the lake?

A. The height of Lake Michigan generally varied during February 22nd and 23rd, at the time of the tests, from plus .5 up to plus .9, in round numbers; but the elevation of the lake varied two or three-tenths within half an hour, at times.

Q. Were the meters run continuously during the period?

A. Yes, they were run continuously except possibly they were drawn out of the water occasionally to see that they were working as well as could be expected.

Q. State what you did on March 8, in connection with making tests?

Mr. Hopkins: What was the absolute gage elevation of the lake, have you got it? You said .5 to .9?

A. I have it plotted.

Mr. Wilkerson: About putting this data in, you can use your own judgment, but we will argue this case as finally made up.

Mr. Adcock: I stated in the beginning that we would submit to you any papers that were referred to, and all the field notes that have been made by the engineers; or if you want to encumber the record, we can call all these witnesses and have them testify.

Mr. Wilkerson: We have no disposition to encumber the record; only, if there is a conclusion stated upon a hypothesis which is not perfectly clear in the record, we shall insist to the court upon the adoption of the hypothesis most favorable to our side of the case, in the absence of absolute data.

The Witness: We made another measurement on March 8, as stated before. I did this to have a check upon the first one; and tried to make it under a little better conditions; used more current meters, more discharge sections.

Mr. Adcock: It was a more complete test, wasn't it?

A. Yes.

Q. And ran over a longer period?

A. Yes, it ran a longer period.

Mr. Wilkerson: What was the date of it?

A. March 8 and 9.

Mr. Adcock: The weather conditions were better, were they not?

A. The weather conditions were better.

Prior to increasing the flow, we tried to get as near uniform flow at about 4,000 cubic feet per second as was possible.

Q. When did you start in flowing 4,000 cubic feet per second?

A. We started in on that day. It was early in the morning of March 8.

Q. What time?

A. I said about four or five o'clock we started to change the flow to obtain this 4,000 foot flow. We did it as soon as it was possible, after our lighting load went off.

Q. You think that was about four o'clock?

A. That is my recollection.

Q. When did you have the Controlling Works completely

changed, so that the volume of 4,000 cubic feet per second would pass through those Works?

A. That was changed so that we seemed to have a fairly even flow there for some distance above the Controlling Works; and the flow was increased at 12 o'clock noon to 10,000 cubic feet per second.

Mr. Wilkerson: What was the flow when you commenced to cut it down?

A. I haven't that in mind, but I imagine it was in the neighborhood of 7,000 cubic feet per second.

Q. You cut it from 7,000 to 4,000; then increased it?

A. Yes, increased it from 4,000 to 10,000.

Mr. Adcock: Q. For how long did you maintain the flow at 4,000 cubic feet per second? That was about from three or four in the morning until twelve noon of March 8?

A. That was at the Controlling Works. Of course it took some time to get the rest of the channel flowing that amount. For instance, around the different gaging stations the flow seemed to vary between four and five thousand cubic feet per second, at the different sections, at twelve noon, when we changed the flow.

Q. That was before you changed it from 4,000 to 10,000 at Lockport?

A. Yes. The flow was put on at about 11:50 in the morning and at 12:00 noon, or shortly after that, there was 10,000 going through the Controlling Works and power house at Lockport; and the flow as indicated there got up as high as 10,500; but it ran at 10,000 or above until one A. M. of the following day.

Q. That was on March 9th.

A. At 3:30, it was 9500; that was as close as we got it. After that, the water had to be shut off. There were discharge sections at Dearborn Street, Loomis Street, Robey Street, Willow Spring, Lemont and at Lockport; the Lockport discharge section being about a half a mile this side, or towards Chicago, from the old Controlling Works in the Rock Section.

Q. Will you just name those the other way from Lockport up; first was Lockport?

A. First was the Controlling Works and then the Lockport discharge section; Lemont, Willow Springs, Robey Street, which is the junction of the Chicago River and the Canal; Loomis Street, Dearborn Street.

Q. Just give the distances if you will please?

A. Distance from where?

Q. From the Controlling Works to Lockport?

A. From the Power House to Lockport 13,000 feet; from Lockport discharge section to Lemont 37,200; Lemont to Willow Springs 39,200 feet; Willow Springs to Summit 28,400 feet; Summit to Robey Street, 40,100 feet; Robey Street to Loomis Street 5650 feet; Loomis Street to Dearborn 22450 feet; Dearborn Street to Lake Michigan 5400 feet. That will be more accurate than the answer in miles.

For the record here, we will submit a table giving this in feet and miles from the Power House to Lake Michigan.

Q. Give us the miles?

A. These are subject to correction: From the Power House to Lockport, 2.46 miles; to Lemont from the same place (I will give the distances every time from the Power House), 9.51 miles; Willow Springs, 16.93 miles; Summit, 22.30 miles; Robey Street, 29.90 miles; Loomis Street, 31.0 miles; Dearborn Street, 35.2 miles; Lake Michigan, 36.3.

Q. The flow at the Controlling Works averaged 10,000 cubic feet per second from 12:00 o'clock noon until 2:45 the next morning?

A. Yes, a time interval of 14 hours and 45 minutes.

Q. Will you state Mr. Witness what the flow was at the Lockport Station?

A. The flow at the Lockport discharge section was approximately 4,000 cubic feet per second when we started, and the indicated flow was 8,000 at about half past twelve, or half an hour later. At 1:50 to 2:00 o'clock, the flow at this station reached a little over 8900 cubic feet per second, and it ran approximately at that flow until 5:30 P. M. of March 8. It then increased to 10,000, which it reached at 7:00 P. M. of March 8.

The flow at this discharge section then varied from 10,000 to 10,400, and down to 9500 at 3:30 A. M. of March 9. That is the Lockport discharge.

Q. Now Mr. Witness, on all those sections that you have mentioned there, the vertical coefficients were obtained, and the work was done by Mr. Blanchard, was it not?

A. Under his direction, and most of it personally by him. These gage readings and measurements were made—

Q. And from 12:00 o'clock noon until about 5:00 o'clock the next morning, was it, at these different sections current meters were run continuously, and continuous readings were taken?

A. They were run continuously from about 10:00 A. M. of March 8, until 9:30 to 10:00 A. M. the next day, with the ex-

ception of the Dearborn Street Section, which was discontinued at 12:00 o'clock midnight on account of an accident to the meter; and also at Lemont. At those two places we had no record from 12:00 o'clock midnight, or 12 hours after the test started.

Q. Will you take the next station?

A. The next station is Lemont; and the flow at Lemont at about 12:00 o'clock varied between 4500 cubic feet per second and 5,000.

Q. That is 12:00 o'clock noon of March 8?

A. March 8. It gradually rose, so that at one o'clock, or one hour after the flow was increased, there was a flow of approximately 8500 cubic feet per second. It then gradually increased—

Mr. Wilkerson: When you say "gradually" you mean what?

A. Near a straight line; "uniform" would be better possibly. It increased uniformly from one o'clock to approximately two o'clock. In connection with the Lemont station, it did not start to increase until 12:20. At 2:00 o'clock it reached 9100 cubic feet, when it seemed to vary from a little above 9,000 to a little below 9,000, from 2:00 P. M. until 6:00 P. M. when there was a fairly uniform increase to 8:00 P. M., when the flow was 9600 cubic feet. It ran fairly uniform at this same discharge until about 9:30, and from 9:30 it increased uniformly to 10:00, when there was an indicated discharge at Lemont of 10,000 cubic feet per second. And it continued at approximately that discharge until 12:00 o'clock, when the meter, as I said, was damaged; got out of order.

Q. How long after the water was turned on?

A. It was ten hours after the water was turned on.

Q. That is after it was increased?

A. After the water was increased from 4,000 to 10,000, before we got a discharge of 10,000 cubic feet at Lemont.

At Willow Springs, the flow started to increase at about 12:45 P. M. From that time, it uniformly increased until 1:10 or 1:15 when the flow was 7,000 cubic feet per second. From this time until 4:00 P. M. the flow uniformly increased so that the discharge at Willow Springs was 7800 cubic feet per second. It ran practically at the same discharge until 6:10 P. M. when there was a discharge of 8,000 cubic feet per second. From 6:10 it increased uniformly until 9:30 P. M. when the discharge was 9,000 cubic feet per second. From 9:30, the increase was uniform to 3:50, when the highest discharge was reached, amounting to 9300 cubic feet per second.

Q. That is 3:50 the morning of March 9?

A. The 9th. From then on the water dropped slightly until 6:10 or 6:20, when there was a flow of 9,000 cubic feet per second. After that the discharge commenced to decrease as the water had been lessened at Lockport.

The next station where a discharge measurement was made was Robey street. The flow started to increase at 1:35 or 1:40, and at that time the indicated flow at Robey street was about 4600 cubic feet per second. That was at 1:35 when it started to increase, and it increased uniformly to 2:20 when the flow was 5900. From that time to 4:40 P. M., the flow as indicated was practically constant. There was a uniform increase from 4:40 to 5:40, the flow increasing to 6500. From this time, that is from 5:40 P. M. to 12:00 o'clock midnight, the flow increased fairly uniformly and the discharge was 7800 cubic feet. It ran fairly constant from this time to 4:00 A. M., the discharge varying between 7800 and 7900 cubic feet. Beginning at 4:00 A. M. the flow gradually increased so that at 6:40 to 6:50 it ran a maximum of 8400 cubic feet per second. From that point the discharge decreased. The change had been made at Lockport before that.

The next gaging was at Loomis street. At the beginning of the test, the flow at Loomis street as indicated by the meter was about 3800 cubic feet. The first indication of an increase of flow, that was at all marked, was at 2:00 P. M. From 2:00 P. M. until 3:20, there was a uniform increase and the flow was 5100. From this time to 12:30 A. M. of March 9, the flow increased fairly uniformly and there was a discharge of 7,000 cubic feet per second.

Q. What hour was that?

A. At 12:30.

Q. A. M.?

A. A. M. From 1:20 until 4:00 o'clock in the morning, the meter was out of service and was being repaired, and the record on that section was incomplete during that stretch; but at 4:20 the flow was 7,000 cubic feet per second and increased gradually to a maximum of 7200 cubic feet per second at 8:30 A. M., when the flow started to decrease.

In regard to Dearborn street, I wish it understood that this section and the discharge is affected by the lake which is only a mile away from it. The discharge at the beginning of the test, as indicated by the discharge measurement at this place, was about 4200 cubic feet per second. The first marked indication of a change in the discharge started at four o'clock

P. M. of March 8, when it uniformly increased, or practically uniformly increased, to the end of the test at 12:00 o'clock midnight, when the discharge amounted to 7300 cubic feet per second.

As stated before, the meter became damaged at that time, or out of order, and no further measurements were made at that section.

Mr. Hopkins: Q. What was the flow at 4:00 P. M. at Dearborn street?

A. 4350 cubic feet per second.

Mr. Adcock: Q. What was done with these meters as to rating them and where were they rated, if at all?

A. These meters were all rated in the testing flume at Ann Arbor.

Q. By whom?

A. By Messrs. Murray Blanchard and H. P. Ramey, one of the engineers under me. These were rated both before and after the tests were made.

Q. What meters were used?

A. On this last test, there were two Haskell and four Price meters.

Q. Were the men that read the meters experienced in that work?

A. I had an engineer in charge, a technical man in charge of each of the stations.

Q. That is civil engineers?

A. Civil Engineers, and they had all been drilled by Mr. Blanchard; and Mr. Ramey himself was on one of these sections, and he had had some experience.

Q. What section was he on?

A Robey street. Mr. Ayers of Mr. Williams' office was in charge of one of the sections.

Q. Which one?

A. Dearborn street.

Q. Where was Mr. Ramey?

A. Robey street.

Q. Who was at the Lockport station?

A. Mr. R. H. Burke, another assistant engineer working under me.

Q. Who was at Lemont?

A. Mr. George E. Haggis, of Mr. Gardner S. Williams' office.

Q. At Willow Springs?

A. Mr. Ripley, one of the assistant engineers of our office.

Q. At Summit?

A. That was only on the 22nd. We did not measure at Summit on March 8.

Mr. Wilkerson: Q. You said you had gages at all points.

A. Yes.

Mr. Adcock: Who was at Loomis street?

A. Mr. I. H. James, formerly of the Lake Survey Office but now working for Mr. Gardner S. Williams.

Q. Have these men experience in connection with reading current meters?

A. I so understand, yes.

Q. By whom were the reductions of the field notes and observations made?

A. Mostly by Messrs. Blanchard and Ramey.

Q. How many men were used on March 8, in connection with this test?

A. There were over 70 men employed upon this test, working practically continuously for 24 hours.

Q. You heard the testimony of Messrs. Moore and Ray with reference to the time it would take to change to a uniform flow of 10,000 cubic feet per second from 4167 cubic feet per second and the statement was made that it would take approximately 2½ to 3 hours. From these experiments that you made, do you think that would be possible?

Mr. Hopkins: The tests were not the same, because in the hypothetical question I assumed that the Lockport gates were opened to 14,000 cubic feet per second.

(Question read.)

Mr. Wilkerson: I object to that on the ground that there is an erroneous assumption in the question as to the testimony of the Government's witnesses; and that it appears from the experiments themselves alleged to have been made under the direction of the witness that it is impossible to reach a conclusion by the witness with reference to the matters about which he is assuming to testify?

A. It would be absolutely impossible.

Mr. Adcock: Q. What would be your estimate of the time it would take to establish this flow of 10,000 cubic feet per second throughout the entire channel from a flow of 4167 cubic feet per second?

A. I doubt if you could get more than 9/10ths of the total change in less than from 22 to 24 hours at Robey street.

Mr. Wilkerson: Q. That is to say your conclusion is that you would get 9/10th of the total change at Robey street in from 22 to 24 hours?

A. In other words it would take from 22 to 24 hours to set up a flow of 9,000 cubic feet per second at Robey street.

Q. At Robey street?

A. Yes, when the channel flow at Lockport has been increased from 4,100 to 10,000.

Q. And would the same percentages apply, if there were a greater maximum of flow at the Controlling Works?

A. You want me to answer that question now or on cross-examination?

Mr. Wilkerson: I will withdraw it.

Mr. Adcock: Q. You mean by that you would have approximately 9,000 cubic feet per second flowing past Robey street in 22 to 24 hours after the change was made?

A. Yes.

Q. How long before you would have 10,000 cubic feet?

A. That would be a much longer time, as in my opinion the increase would not be so rapid; it would flatten out. Just how long it would take, I do not know.

Q. In your direct testimony, Mr. Witness, I believe you testified as to how long it would take storm water coming from the Chicago River basin to concentrate in the Chicago River in cases of storm?

A. I believe I did.

Q. Have you made any additional study with reference to that matter since you testified?

A. Yes. We made a study by the gaging of several of the large sewerage districts, in which the sewage has been measured, and we have made a study of the time after the rain starts until the maximum discharge was reached. This study has been very careful and has been carried on in the 39th Street District, the Robey Street District and the Diversey avenue sewerage district. These are three separate and distinct areas about Chicago; one of them being on the South side, another on the West side and another on the North side.

Mr. Wilkerson: I object to this, on the general ground of incompetency; and on the ground that there is not sufficient basis shown for the statement of a conclusion at this time. And on the further ground that the testimony is improper in this case for any purpose, for the reason that this suit being an attempt to review the decision of the executive branch of the Government, data has no place in this record which was not submitted for the consideration of the Executive Officer who made the decision. That it is improper to be offered in court until it has been first considered by the War Department.

Mr. Adcock: With reference to the tests or calculations which were made in connection with the measurement of the sewage and storm waters in the various sewerage districts mentioned by the witness, I will submit for the examination of the Government the field notes made by various persons making the test. Or if counsel now desires, I will produce the witnesses who made the measurements and let them testify as to what they actually did.

Mr. Wilkerson: The witness may proceed to answer the question with the understanding that after an inspection of these things we may desire to make a motion to strike out assigning specific reasons which may appear from an inspection of the notes.

Mr. Adcock: I assume the counsel means, when he says he will make a motion to strike out, that it will be in the nature of a notification to us that he desires us to call witnesses or make further proof with reference to the measurements made.

Mr. Wilkerson: Yes; or it might be for reasons apparent on the face of the notes themselves. An inspection of the notes themselves might disclose some defect apparent on the surface of the observations.

Mr. Adcock: Which may be cured possibly by calling the witnesses.

Mr. Wilkerson: It might or might not be.

Mr. Adcock: Yes, depending upon the circumstances in each case.

Mr. Wilkerson: That is merely in order to facilitate the examination and to economize on time.

Mr. Adcock: And also to save the expense of taking the testimony, having it printed, etc.

The Witness: I would say in regard to these measurements that they were authorized by the Board of Trustees upon my recommendation, and have been carried on under my direction, and the results have been worked up under my direction.

Q. That is the Chief of Engineers was directed by a resolution or ordinance of the Board of Trustees to make these measurements?

A. To install weirs and measure certain discharges from certain well defined sewerage districts. From these studies—

Mr. Wilkerson: May I ask, so that we may have it in the record, whether with reference to these storm water measurements or the measurements in the river and the canal about which the witness has testified this morning, any notice was

given by the District to any of the Government Officials with reference to the making of either set of observations.

Mr. Adcock: I will say that no notice was given, nor did the Government give us notice of the measurement of the Split Section of the Niagara River, at the time they made that; nor at Lockport.

Mr. Wilkerson: I merely ask the question. There are two propositions involved as to notice, entirely different; the necessity for the notice in one case being based upon a fundamental legal proposition not in the other, as I conceive it.

Mr. Adcock: No notice was given by the Government with reference to the measurement of the canal at Lemont by Mr. Ray and Mr. Moore.

Mr. Wilkerson: The same observation applies to those measurements as to the other.

Mr. Adcock: I also make the offer to repeat these tests when a representative of the Government may be present, at the expense of the Government however, as we consider the tests that have already been made sufficient for our purposes and for the purposes of this case.

The Witness: (Continuing) From these studies as near as we can determine, the time of concentration of the storm run-off on the large sewerage areas upon the urban drainage area of the city of Chicago will be from 3 to 3½ hours. The suburban district along the North Branch North of Lawrence avenue would take in the neighborhood of 24 hours to reach the maximum. The discharge of 10,000 cubic feet per second will occur, in heavy storm, in the neighborhood of 3 to 4 hours.

Mr. Adcock: Q. Where would that be concentrated?

A. I mean there would be that amount of water coming into the Chicago River South of Lawrence avenue.

Q. Would it be possible to so manipulate the Controlling Works at Lockport as to change the flow from 4167 to 10,000 cubic feet per second so as to prevent any of the storm water or sewage of the city of Chicago going into Lake Michigan?

Mr. Wilkerson: Same objection to that as to the other.

A. It would not.

Q. Will you state the reason?

Mr. Adcock: I assume all this is subject to objection as to materiality and relevancy, anyway.

Mr. Wilkerson: It is all subject to the same objection that I stated.

Mr. Adcock: I understand that all this testimony that has

been taken has been taken subject to objections as to materiality and relevancy, which objections may be made at the time the evidence is presented to the court on the hearing. Is that the fact? That was our original—

Mr. Wilkerson: As to those objections, yes.

Mr. Adcock: Materiality and relevancy. As to competency in matters of form, that is a different proposition.

Q. Why?

A. The engineer or executive in charge of this work of changing the flow from 4167 cubic feet per second to 10,000 cubic feet would have to anticipate every storm by at least from 20 to 21 hours in order to prevent the Chicago River from discharging partly into the lake. This means that every time there was the slightest indication that there might be a rainstorm, the flow would have to be increased so that if a heavy storm did occur, the Chicago River would not be reversed and discharged into Lake Michigan.

Another point is that it would be impossible to maintain a channel from Lake Michigan to Lockport that would ordinarily flow 4167 cubic feet per second and still be capable of flowing 10,000 cubic feet per second when needed.

Q. What is your reason for that?

A. For the reason stated in my direct examination that with such a slow velocity as would obtain with a flow of only 4167 cubic feet per second the channel would fill with sediment coming either from the solids of the sewage and street washings or from the sediment in the lake water itself. The result would be that during the slow flow the channel would be gradually filling up with sediment so that at the time you needed a larger flow there would not be a sufficient cross sectional area to permit the flow of 10,000 cubic feet per second through the canal.

Q. During these tests was the 39th street pumping station in operation?

A. No, except for sewage only.

Q. Except for sewage. Did the pumpage and flow of sewage in your opinion vary, that is in the sewers that emptied in the Chicago River, during the period of each test?

A. Practically not, that is to be of any moment as far as this test was concerned. There was no heavy run-off from the sewers.

Q. In your gaging of the Main Channel and the Chicago River, how long after the flow was changed at Lockport was the effect of this change shown upon the gage at Lemont?

A. The elevation of the water surface at Lemont started

to lower about 27 minutes after the change was made at Lockport.

Q. Take the intervals with reference to the other gaging stations.

A. At Willow Springs 47 minutes; at Summit an hour and 17 minutes; at Robey street 1 hour and 47 minutes.

Q. How about the discharges between those places?

A. The discharge, or the amount of water flowing by these sections, started to increase at the same time that the water surface showed a lowering on the gage, but the full effect of the discharge at Lockport, or at the Power House, was not felt at these different discharge sections until the time as indicated in my previous answer, being several hours later; and in the Chicago River itself it was not obtained.

Q. How do you account for the conclusions reached by Mr. Moore and Mr. Ray with reference to the time it would take to change the discharge?

A. The engineers of the Lake Survey Office measured the water at only one section, that being from the Stevens street Bridge at Lemont. They read the gages at Lemont and Willow Springs and obtained from the Government Office at Chicago, as I understand it, the elevation of Lake Michigan. They had no data as to what the flow at Lockport was. The only place they had an actual discharge measurement at any time was at Lemont from the Stevens street Bridge. The time of change in the level of the water surface at Lemont being observed and also at Willow Springs, and the distance known by them, they assumed that the discharge at Willow Springs changed as the water surface level changed and from this they computed the so-called lag throughout the entire length of the channel, and the Chicago River, and testified that the full effect would be felt in the channel from Lake Michigan to Lockport in not to exceed three hours, whereas this time simply represented a wave of translation and not a full effect of the change of the discharge at Lockport.

Q. Have you any data there showing the variation of the Chicago gage, that is the elevation of the water surface of Lake Michigan during the period of the test, March 8-9?

A. Yes.

Q. What were the variations?

A. The gage at Lake Michigan varied from twelve o'clock noon on March 8, from datum, to plus .3 above datum. There were variations of 1½ tenths in 15 or 20 minutes at times; and

a variation of that kind is sufficient to affect the discharge at Dearborn street somewhat.

Q. You have spoken of the interval of time required to create a change of discharge at various points. Was this in any way similar to the rise or fall of the water surface of a lake at the head or foot of a river, in its effect?

A. In my opinion it is, providing that the time of the change of the elevation of the water surface was comparatively short, and generally if the time of change was gradual or longer, the same general effect would obtain; that is a wave of translation would travel along the river and be indicated on the gages, but would not indicate the time of the full effect of the change of the discharge due to an increase or decrease of the water surface of the lake. In other words, to get the time of the full effect of the change of discharge, the river would have to be measured simultaneously at two or more points.

Q. How long have you been familiar with the Chicago River and the sewage problems connected therewith?

A. From July 7, 1892, to date. I went to work for the Sanitary District upon that date and was on the original survey of the South Branch of the Chicago River for a few months. From some time in September, 1892, until September, 1895, I did not have very much to do with the Chicago River as I was located at Lockport at that time. I was transferred back to Chicago at the latter date, and was more familiar with the river from that time on. And from 1897 to date, I have been in charge of the Chicago River improvement, either as assistant engineer at that time in charge of this improvement, or as assistant chief engineer and chief engineer of the District.

From 1897 until about 1903-4 or '05, I was in direct charge of all the improvements that were being made on the Chicago River.

Q. The depth of the South Branch of the Chicago River before the Sanitary District started work was approximately 16 to 17 feet, was it not?

A. Yes, sir.

Q. And it is now 26 feet?

A. It is now 26 feet except at a few bridge openings; that is the South Branch of the Chicago River?

Q. Yes?

A. From Lake street to the Canal.

Q. That is the central portions?

A. The central 100 feet of the stream is 26 feet in depth with a depth of 16 feet at the Dock lines.

Q. Now you have some maps there of the Chicago River, have you not Mr. Witness?

A. Yes. This map shows the main branch of the Chicago River from the lake to Lake street, showing the North Branch as far north as Kinzie street, and the South Branch of the Chicago River from Lake street to Ashland avenue. This is the stretch that was widened and deepened.

Mr. Adcock: I will ask that these maps produced by the witness, being 5 in number, be marked Wisner's Exhibits 7, 8, 9, 10 and 11, of this date.

(The maps referred to were so marked.)

Recess to 2:00 P. M.

After Recess 2:00 P. M.

GEORGE M. WISNER, resumed the stand and testified further as follows:

Mr. Adcock: Q. You have described have you Mr. Witness Exhibit 7, 8, 9, 10 and 11?

A. I have not described them.

Q. If you have not described them, will you describe the exhibits, and as you do so indicate from the exhibits just what improvements have been made by the Sanitary District in the Chicago River, the South Branch and other branches of the river that may be referred to in those exhibits.

Mr. Wilkerson: You mean by the District alone, on its own initiative?

Mr. Adcock: Yes.

The Witness: And the city of Chicago.

Q. Also indicate the time, so far as your memory serves you, when the improvements were made?

A. These five sheets are maps of the Chicago River from Lake Michigan through the main branch of the River, and South and West on the South Branch of the Chicago River to Ashland avenue, which is about half a mile east of the beginning of the canal.

The maps are drawn accurately to a scale of 200 feet to the inch and indicate the dock lines of the river, the bridges, and generally the physical characteristics of the banks of the river within a block or so—

Q. Is that before or after the improvement?

A. They indicate both, with the exception that it does not show the location of the old bridge piers and center pier protections of the bridges that were removed and changed from the swing type of bridge to the center pier—to the bascule type of bridges. It does indicate the type of bridge, and when it is completed, as stated on the map, for instance State Street Bridge, which was built by the Sanitary District is a Scherzer bascule, as indicated, "built by the S. D. of C." meaning Sanitary District of Chicago, completed 1903. So by looking at these maps at the different bridges, you can learn by whom they were built and when completed.

The lake is on the right hand side of the map, Wisner's Exhibit 7. When I say on the right hand side of the map, I mean to have it so placed that the words "Chicago River" in the part tinted blue reads right side up; that being to the East, and Lake Street being to the West.

The streets like 5th Avenue, LaSalle, Clark, State, run practically north and south, and streets like Kinzie and Lake run east and west. This first sheet shows the junction of the south and the north branches of the river.

On Exhibit 7, which is as I stated the main branch of the river, the improvements made by the Sanitary District consisted of the removal of the State and the Dearborn Street bridges, which bridges were of the center pier swing type such as now exists at Fifth Avenue and Michigan Avenue. These were replaced by the bascule type of bridge giving a wide center opening and doing away with the center pier and the center pier protection, which clogged up the river and interfered with navigation. The Sanitary District also dredged the river in the vicinity of these bridges to a depth of 21 feet.

On the main river, in addition to what was done by the Sanitary District, the city of Chicago removed the LaSalle Street tunnel, deepening the river at that place. The tunnel at LaSalle Street interfered with navigation; the boats at times being stuck on it and blocking the river.

Wisner's Exhibit 8 of this date consists of a map of the same scale extending south from Lake Street to 12th Street showing the docks on the river before and after improvements made by the Sanitary District. This stretch of the river has been widened practically throughout its entire length, the widening being indicated by the dark blue tint. By applying a scale to this dark blue tinted area, the amount of the widening can be determined at any place. Generally, it varies in width from nothing to approximately 90 feet. The part tinted green of which there are two places indicated on this

sheet are stretches along the river which have not as yet been widened for the reason that the property has not been acquired by the Sanitary District, but is included in the general project, and it is expected will be obtained and widened within the next year.

Q. Do you know whether any suits are now pending?

A. There are condemnation suits pending against both of these pieces of property.

Q. You are referring now to—

A. To the parts tinted green, one being on the east side of the river between Van Buren Street and Harrison Street and labeled "Union Elevated R. R. Co. Power House."

Q. That is what is called the Union Loop Power House?

A. That is called the Union Loop Power House. The other is indicated by "Tract Number 201," the 201 being in a circle and being just north of Taylor Street.

The Sanitary District has widened and excavated the river throughout this stretch to 26 feet in depth; has removed all of that part tinted a dark blue thus widening the river, and has rebuilt all the docks where the river was widened.

Q. What is the width?

A. The width where completed is at least 200 feet.

Q. That is all except those two points?

A. All except those two that have not yet been excavated. The District has removed a center pier bridge and built a bascule bridge at Randolph Street, which was completed in 1903.

The Washington Street Bridge and the tunnel thereunder were removed by the City of Chicago and a new bridge completed in 1913 at this street.

The Madison Street bridge, the one that now exists, is of the center pier swing type, and is to be removed by the city of Chicago.

Q. When you say "is to be removed," what do you mean?

A. It has been ordered out and plans and specifications are being prepared and it will be rebuilt within the very near future.

The Jackson Boulevard Bridge is now being removed by the Sanitary District, and is to be replaced by a bridge of the bascule type, having a wide opening.

Q. You spoke of the Madison Street Bridge and the Jackson Boulevard Bridge; they are to be rebuilt. What channel opening are they to have, and what cross section there?

A. The opening of the Jackson Boulevard Bridge will be

167 feet in width; the one at Madison Street, as I recall, is to be 180 feet, somewhere in that neighborhood.

Q. How does that compare with the bridges that are being removed?

A. The bridge openings there are only about 55 to 60 feet in width at the present time. At Jackson Boulevard, the opening is a little wider, I believe about 90 feet.

The next bridge to the south is the Metropolitan Elevated Railroad Company Bridge. This was ordered out by the Secretary of War.

Q. Do you know when under the order of the Secretary of War the Metropolitan Bridge was to be removed?

A. By December 1st, or 31st of this year, I have forgotten which.

It is part of the contemplated plan of the Sanitary District to remove and replace the Van Buren Street Bridge with a bridge having a 200 foot opening.

The Harrison Street Bridge, which was of the center pier type has been removed and rebuilt by the Sanitary District, being completed in 1905.

Polk Street Bridge which was of a similar character has been removed and was rebuilt by the City of Chicago, being completed in 1910.

Taylor Street Bridge which was of the center pier type was removed by the Sanitary District and rebuilt in 1900.

The railroad bridge just south of that and indicated as "B. & O. C. T. R. R." was of the center pier type and was built by the Sanitary District, being completed in 1901.

Twelfth Street Bridge has been ordered out by the Secretary of War and is to be rebuilt jointly by the city of Chicago and the Sanitary District, with an opening of 200 feet instead of the present opening of about 55 to 60 feet.

Wisner Exhibit number 9, is the third sheet of this set, being of the same scale, and is a map of the south branch from 12th Street to 18th Street inclusive. The part tinted a dark blue represents the river widening performed by the Sanitary District, and the part tinted green is a piece of property not yet obtained, but which is under condemnation; and in my opinion will be obtained within the next few months, when this whole stretch of the river will have been completed; so that from Lake Street to the beginning of the Drainage Canal, with the exception of the three pieces mentioned and the stretch of the river at the Metropolitan Elevated, the entire river has been widened to at least 200 feet and even to 26 feet or more, with

the exception of the bridge openings of the old center pier bridges.

The widening on this stretch of the river varies from zero to 80 feet in width. The river was redocked and deepened as stated.

The bridge marked "St. Charles Air Line" which is practically on 16th Street, is to be rebuilt by the Railroad companies. Plans are now being prepared, and this bridge is to be taken out and replaced with a 200 foot opening bridge.

The 18th Street bridge which was of center pier type was rebuilt and replaced with a bascule type bridge completed in 1905 by the Sanitary District.

Wisner's Exhibit 10 of this date is a continuation of this map and gives the Chicago River on the same scale, 200 feet to the inch from 18th Street to Halsted Street. The same general tinting indicates what has been done by the Sanitary District. The widening varies from nothing to nearly 140 feet in width at Collision Bend.

Q. Where did that get its name?

A. It got its name on account of there being so many collisions at this place before this widening was made; I mean collisions between vessels.

Q. What was the original width at the Bend?

A. A little over 100 feet. There was a narrow point on the river immediately south, or west of 18th Street, and at that place the Sanitary District widened it about 120 feet at the widest point. The old 18th Street bridge, on account of the narrow river and bend in it, the vessels were unable to use but one bridge opening, that one being on the east side of the river. By that I mean vessels of any size.

The bridge marked "P. Ft. W. & C. R. R." is a bridge owned by the Pennsylvania Railroad Company, and is now in the process of being removed; a new bridge having been built at this place with I think a 200 foot opening.

The Canal Street Bridge was built by the Sanitary District and completed in 1903. That was not of the center pier type, but was of a narrow opening type, known as a jacknife. It stood askew and was a very difficult place for navigation.

The 26th Street Bridge was of the center pier type and was removed; rebuilt by the Sanitary District, completed in 1906.

The next sheet shows in the same way the improvements made by the Sanitary District from Halsted Street to Ashland Avenue. The part near Ashland Avenue tinted brown is a turning basin that was built by the United States Government to facilitate the turning around of vessels after going up the

river. Generally, this river was widened throughout this stretch, throughout the entire length, to give a channel which is now at least 200 feet wide and 26 feet deep.

The Sanitary District removed a center pier bridge and rebuilt with a bascule bridge at Main or Throop Street, completing it in 1903. And one at Loomis or Deering Street, completing that in 1904; and one at Ashland Avenue completing that in 1903.

The river from Ashland Avenue down the West Fork to the beginning of the Canal was over 200 feet in width, and was simply deepened by the Sanitary District to 26 feet in depth.

At the lower end of this last sheet the water as indicated on the left hand side of the sheet is the west fork of the south branch, from which the canal starts at Robey Street.

The indicated water to the right of the map is the South Fork of the South Branch, the far end of which is known as Bubbly Creek, being located near the Stock Yards, and having been mentioned in this case several times.

The middle water stretch is the entrance to the old Illinois and Michigan Canal.

On Wisner's Exhibit Number 8, I neglected to mention that the City of Chicago had removed and rebuilt a tunnel under the Chicago River immediately North of Van Buren Street, and indicated on this map as "West Chicago Street Railway tunnel." This prevented the deepening of the river for some time, as the top of the tunnel was about, as I remember, 20 feet below the surface, 20 or 21 feet below datum.

Q. The Government produced certain witnesses known as lake captains, who referred to certain critical points or difficult points of navigation. They mentioned Van Buren Street, Jackson Boulevard, Madison Street, 12th Street, Pennsylvania Bridge, 16th Street Bridge, the St. Charles Air Line Bridge. Those are all bridges which have been ordered out by the United States Government, or are points where new bridges are being constructed, are they not?

A. Yes, sir.

Q. In your opinion, when those bridges are completed, the new bridges are completed with approximately 200 feet clear channel opening, will there be any difficulty in navigating the Chicago River at this point?

Mr. Hopkins: Objected to, the witness is not qualified to answer that. He is not a navigator. As I understand it at those bridges, it is not widened to 200 feet.

Mr. Adcock: Approximately.

Mr. Hopkins: 167 feet.

The Witness: They vary from that to 200 feet in width.

Mr. Adcock: Q. They vary from 167 feet to 200?

A. From the narrowest, about 140 feet, some of the first ones built, up to about 200 feet in width.

Q. But by-passes were arranged for those—

A. For the narrower openings.

Q. The narrower openings, so that you would have a cross sectional capacity of approximately 200 feet in width there?

A. Nearly that; some of them may be a little short of that.

Mr. Adcock: In view of the counsel's objection, still insisting that the witness is qualified to answer because of the facts stated in his previous examination, I will ask the witness to state what experience he has had in connection with determining the capacity of the Chicago River at various flows of water to determine the condition of navigation.

A. As stated, I have been in charge of this improvement, and have watched vessels going up and down this river for the past 21 years; and have been on them at times before the opening of the canal and afterward. And I know of my own knowledge that vessels can get through that river now, and do get through it that could not by any physical possibility have gone through prior to the improvements made by the Sanitary District.

Q. Have you considered the flowing capacity of the river, the current that may be created by various flows of water at different points in the river?

A. Yes.

Q. That is part of your duty is it not as an engineer, assistant engineer of the Sanitary District, and as Chief Engineer?

A. Yes.

Q. Go ahead and answer the question now.

A. In my opinion, there will not be any great difficulty in navigating the river after all these improvements are made, and in my opinion there is no great difficulty in navigating the river at this time, with the exception of the times when old bridges are being removed and new ones are being built, when from the nature of the structure that is to be built the river is more or less clogged by temporary works.

Q. Such as cofferdams?

A. Such as cofferdams, and maintaining traffic on the old bridge, during the construction of the new one.

Q. The Sanitary District has expended approximately how much money in deepening and widening the Chicago River and in building the bridges which you have mentioned?

A. Approximately eleven and one-half million dollars.

Q. Did you ever observe the Chicago River prior to 1900 when it was in flood?

A. Yes.

Q. What effect did the flood conditions have upon navigation in the Chicago River?

A. It prevented navigation during the excessive floods and created a current much in excess of anything that we have at this time. This occurred usually every year, sometimes two or three times a year.

Q. That is during the navigable season of the year?

A. Sometimes during the navigable season, and sometimes in what is known as not the navigable season; but as a matter of fact the Chicago River is always open to navigation. I never remember of having seen the South Branch frozen over.

Q. Do they have the same conditions now as to floods?

A. No sir, they are entirely done away with.

Q. One of the witnesses, one of the lake captains, I think it was Mr. Minskey, testified that certain boats under his charge were injured while lying in the vicinity of 18th Street in the year 1912, was it not?

A. I have forgotten the exact date, but at any rate it was since the improvements made by the Sanitary District at 18th Street, and the widening of the river between 12th and 22nd Streets.

Q. Do you remember the dimensions of the boats which he stated he had in the river at that time?

A. He stated that he had the steamer Gilchrist and Lake Shore, I think it was, and he gave the beam as being 52 feet. I looked it up in the Official Blue Book, as it is called, giving the dimensions of steam vessels on the Great Lakes, and found the steamer Gilchrist was 356 feet long by 50 feet beam, and the Lake Shore was a sister ship, of the same size.

Q. He stated that those boats were tied up in the vicinity of 18th Street. Would it have been possible to have boats of that size lying alongside the dock at the places indicated, if the Sanitary District had not widened and deepened at that point?

A. No, sir.

Q. How do you work that out?

Mr. Adcock: I hand the witness two sheets which I ask be marked Wisner Exhibits 12 and 13 respectively of this date, and ask the witness to describe the exhibits and state what is shown upon them.

(Documents handed witness were marked Wisner's Exhibits 12 and 13, May 20, 1914.)

A. Wisner's Exhibit 12, is an outline of the docks along the Chicago River from just North of 18th Street to just South or West of the Pennsylvania Railroad Bridge at Stewart Avenue; is drawn to a scale which is twice as large as Wisner's Exhibit 7 to 11; that is it is 50 feet to the inch, and is therefore four times the size of the other maps, but is accurate, and simply shows 18th Street. It shows the dock lines prior to the improvements made by the Sanitary District, and on the right hand side of the map, the line that follows to the right—

Q. Which is west?

A. Which is west, is the line to which the Sanitary District widened the river from 18th Street to below the Pennsylvania Railroad Bridge at Stewart Avenue. When I say the right, I mean the right when looking at 18th Street, and it reads right side up.

This would also be observed by the direction indication of the arrow showing North, East, South and West.

Upon this, in dotted lines, have been plotted the outlines of a boat which is 356 feet long by 50 foot beam. The one at the lower end of the map—

Q. Is that the size of the boat referred to?

A. That is the size of the Gilchrist, which Mr. Minskey testified he had lying between 18th Street and the Pennsylvania Railroad Bridge, on the East side of the river.

At 18th Street, there existed an old center pier bridge and protection; this protection being shown on this map by two horizontal lines and diagonal lines coming together which is practically in the shape of the protections as built. And in the East Draw of this bridge which was the only draw that could be used by the larger boats, is plotted the outlines of the boat Gilchrist to scale, showing that it was physically impossible for it to have gone through this bridge opening, if the old bridge existed there, for the reason that the boat would get aground at the stern and be against the center pier midships, and aground forward.

I have also plotted in dotted lines the same size steamer between the two bridges, although it could not have gotten through; and another one a little further on, showing that if that boat had been lying alongside of the dock it would have been physically impossible for another boat of the same size to have passed through.

Q. That is under the old conditions?

A. Under the old conditions.

At the place indicated as "Pennsylvania R. R.," meaning the Pennsylvania Railroad Company's bridge, there is plotted a boat of the same size showing that it would have been almost impossible for it to have gone through the draw. This bridge is now about to be removed.

On Wisner's Exhibit 13 of this date, to the same scale, is plotted the river as it exists today. And I have plotted on the east side of the river just south of 18th Street the steamer Gilchrist, indicated by the figures "356 by 50," meaning the size of the boat; and have also plotted a vessel 600 feet in length and 55 foot beam, showing that with this vessel lying alongside of the dock, a vessel of that size could have passed if carefully handled without necessarily damaging the boat lying alongside the dock.

These improvements have now been made, and it necessarily follows that the river has a larger navigable capacity now than it did prior to the improvements being made.

Mr. Wilkerson: You have not indicated in your testimony, but that was all done under the authorization of the War Department, was it not?

A. This was done under the General 200 Foot Project.

Mr. Adcock: Q. The largest portion of the work which you have mentioned, done by the Sanitary District, was carried out under what is known as the Sanitary District Project of 1900, was it not?

A. Yes.

Q. And a permit was obtained from the Secretary of War approving the plans of that project, was there not?

A. Yes, sir.

Mr. Wilkerson: Q. And from time to time your plans were submitted and approved by the War Department and the Chief of Engineers?

A. Only as far as the bridges were concerned. The widening was only submitted, as I recall it, at one time, the widening and deepening.

Q. That was a general authorization for that?

A. Yes.

Mr. Adcock: Q. And the permits with the applications therefor are attached, I believe to the answer of the Sanitary District to the bill of complaint last filed, being equity number 114. I believe that project was referred to by Mr. Cooley, in his testimony was it not, Mr. Wisner. Is that correct?

A. Yes.

Q. And he described it. How about the draft of boats now

as compared with those that could navigate the Chicago River prior to the work of the Sanitary District you described?

A. A boat drawing over 16 feet of water could not have navigated the Chicago River prior to the improvements made by the Sanitary District; at the present time they can probably navigate drawing 21 feet, the reason it is only 21 feet being that the Main Branch of the river was never deepened to more than that depth.

Q. Prior to the improvements made by the Sanitary District and prior to the opening of the channel, have you ever seen any boats stuck in the river?

A. Many times.

Q. How is the river now compared with the condition it was previously to the improvements of the Sanitary District with reference to the tortuousness of the river?

A. It is much straighter.

Q. Is that any benefit to navigation?

A. Yes, indeed.

Q. Do you remember when the City of Chicago completed the Illinois and Michigan Canal on what is called the Deep Cut Plan, so that water could flow by gravity from Lake Michigan or from the Chicago River through the Illinois and Michigan Canal into the Des Plaines River?

A. I think it was in 1871.

Q. Do you know the capacity of the Illinois and Michigan Canal to withdraw water from Lake Michigan?

A. It was approximately 24,000 cubic feet per minute, 400 per second.

Q. In 1883, was it not, the City of Chicago installed pumping works at Bridgeport, and from that year the pumping works were placed in operation? Do you know what the capacity of the pumps was, and how much water was regularly pumped from the Chicago River into the Illinois and Michigan Canal, which water flowed into the Des Plaines River and thence into the Illinois River?

A. Generally, from 50 to 60,000 cubic feet per minute.

Q. Did the withdrawal of the water in 1871 and 1873, and from 1883 on, until the opening of the Drainage Channel, have any effect upon the force and current of the Chicago River during a considerable portion of each year?

Mr. Wilkerson: You do not contend he knows anything about that, do you?

Mr. Adcock: Yes, he is qualified.

Mr. Wilkerson: No, he said—down to what time?

Mr. Adcock: Q. You know the ordinary dry weather run-off of the Chicago River, do you, Mr. Wisner?

A. Yes. Exclusive of sewage?

Q. Yes?

Mr. Wilkerson: If he thinks he can answer all right. I do not think myself he is qualified to answer it.

Mr. Adcock: You may answer the question.

Mr. Wilkerson: We may have the quess of the witness. It is perfectly obvious it is a mere guess.

A. It had the practical effect of reversing the Chicago River during the dry weather seasons, and during the season when the snow was falling and not melting and running off; when there was a dry weather flow.

Q. When there was a minimum of run-off?

A. Yes.

Q. There was some suggestion made by counsel that perhaps you are not qualified to answer this question. Will you just state what facts it is necessary for an engineer to determine in order to state when the current of the Chicago River would be reversed in each year?

A. He would have to be acquainted with the Chicago River as to its characteristics during the dry season; with the approximate population, amount of pumping for the domestic supply, the drinking water; and be familiar generally with the amount of pumping and the amount of sewage that runs away; the different sewerage districts, in a general way. When I answer this, I do not mean to say it is absolutely correct, but I do know enough about it to know that there would be a substantial reversal of the flow in the Chicago River with the amount of water running off during the dry periods.

Q. That is the Chicago River, instead of flowing towards the lake would flow away from the lake during a portion of each year under those conditions. Is that it?

A. Yes, sir.

Q. And there would be some considerable amount of water extracted from Lake Michigan itself?

A. Bound to be.

Q. Mr. Witness, you stated this morning the results of the tests made on the Drainage Canal on February 22, and March 8-9 of this year, made under your direction; and in the course of your testimony you referred to certain charts upon which the discharge at various gaging sections was plotted. I ask that the six sheets which I now hand the Commissioner,

be marked Wisner's Exhibits 14 A, B, C, D, E and F. I will ask you to state what appears upon those exhibits, for the convenience of the court and counsel.

(Charts shown to witness were here marked respectively Wisner's Exhibits 14 A, B, C, D, E and F, May 20, 1914.)

A. Wisner's Exhibit 14A, represents graphically the discharge of the Sanitary District Canal at the Power House and Controlling Works on February 22 and 23, as plotted up from the records kept at that place.

In the left hand column is given the discharge in cubic feet per second. In the horizontal columns are the hours and the date. The figure in the lower right hand corner is the discharge from 6:30 A. M. on February 22, to 3:00 P. M.; and if the sheet had been large enough would be joined on to the same line on the left hand side of the page under "3:00 P. M." and opposite "3,000."

Wisner's Exhibit 14B, represents graphically the discharge on February 22 and 23, as measured at the Power House, Lemont, Summit and Dearborn Streets. The figures on the left hand side of the page being the discharge in cubic feet per second, and the time being plotted in the horizontal at the top of the page.

Wisner's Exhibit 14C, represents graphically the gage readings from Lake Michigan to the Power House from 6:00 A. M. on February 22d to 2:00 P. M. on February 23; there being ten different places as indicated in which gages were maintained and read, during the time this test was being carried on.

Wisner's Exhibits 14D, 14E and 14F, represent the same as the previous three sheets, being the test carried on during March 8 and 9.

Adjourned to Thursday May 21, 2:00 o'clock P. M.

GEORGE M. WISNER resumed the stand and testified further as follows:

Direct Examination Resumed by Mr. Adcock.

Q. Did the Sanitary District lower the Kampsville and LaGrange dams in the Illinois River at any time?

A. The Sanitary District lowered the Kampsville dam 2 feet and we attempted to lower the other one, but with the restrictions placed upon us by the Government we did not succeed in getting it down.

Q. When was that work done?

A. I can get that date for you.

Q. It was subsequent to April, 1904, wasn't it?

A. Oh, yes, it was 1905 or 1906.

Q. And that was done pursuant to a permit from the Secretary of War?

A. From the Secretary of War, yes.

Q. Are you familiar with the navigable capacity of the Illinois and Michigan Canal from Joliet to Chicago, or from Chicago to Joliet?

A. Yes.

Q. That portion of it?

A. Yes.

Q. When I say navigable capacity, I mean the width, depth, and capacity for admitting boats, large boats.

A. The size of boats that can go through it.

Q. Yes? Was the stretch of the Illinois and Michigan Canal from Chicago to Joliet, that is to what we call the upper basin, the same capacity as that portion of the canal from the upper basin below along the Des Plaines and Illinois Rivers?

A. To Peru.

Q. To Peru?

A. Yes.

Q. During the last 20 years, say?

A. Just the same.

Q. Just the same?

A. The locks are all the same size.

Q. The locks are all the same depth, the water is the same?

A. They vary a little bit, but practically the same.

Mr. Adcock: That is all.

Adjourned to Tuesday June 15, 1914, at 10:00 o'clock A. M.

June 15, 1914, 10:00 A. M.

GEORGE M. WISNER resumed the stand and testified further as follows:

Cross-Examination by Mr. Hopkins.

Q. In making these tests as to the rate of flow in the canal, you made every effort did you to get it as accurate as possible?

A. I employed the most competent men that I could obtain from our engineering force, and from some outside men.

Q. Do you consider that their work was accurately done?

A. I told them to follow as nearly as possible the methods pursued by the Lake Survey. This work was under Mr. Blanchard's charge, and my general instructions were to get as accurate results as possible with current meters.

Q. Is your opinion as to the accuracy dependent upon simply what they told you, or do you have opinions of your own in regard to it?

A. It was impossible for me to be at all those discharge sections. I was at one of them, or two or them, part of the time.

Q. On February 22, where were you?

A. At Washington and Dearborn Street, if I remember rightfly.

Q. And on March 8, where were you?

A. Dearborn Street.

Q. What personal work did you do?

A. I did not do any of the personal work, simply that I gave orders to have this work done; and went over the results with them afterward, talked it over with them.

Q. Have you personally had any experience in measuring streams?

A. Oh, some, yes, sir.

Q. With the use of current meters?

A. Some, yes.

Q. Just what has been your experience in that connection?

A. You mean personally, where I handled the meter myself?

Q. Handled the meter and directed the work?

A. As I remember, I never handled the meter myself. I directed the work in the measurement of the Illinois River; and in some current meter measurements of the flow of water through big conduits.

Q. Do you consider then that the results say at Dearborn Street on March 8th, are reasonably accurate?

A. I would say that they were comparatively accurate.

Q. Compared to what?

A. Well, I mean this, that we knew how fast the current was going and we had the flows down and then afterwards we knew how fast it was going when the current had been increased; and as near as we could tell one compared with the other ought to give a fairly good idea of the amount of water that was flowing by this particular station.

Q. In your opinion what was the percentage of accuracy of the volume of flow determined at Dearborn Street during these tests?

A. I have not such a high idea of the accuracy of the current meter as a great many witnesses who have testified on the other side in this case.

Q. Well, what is your idea of the accuracy of these particular measurements?

A. It would be merely a guess, Mr. Hopkins.

Q. Don't you think in testifying as to these tests and what they would show that that would have an important bearing?

A. I suppose it would be an important consideration, but it is as accurate a method as we have for the measurement of large flows of water, with the possible exception of floats in a canal of the size and shape of the Drainage Canal. In my opinion, I think they were as accurate as current meters, possibly more so.

Q. Was this work accepted by you and the district as being as accurate work as Mr. Blanchard could do in this matter?

A. I told him to do just as accurate work as it was possible to do.

Q. And you think he did that?

A. I think he is conscientious and has had training extending over several years; and I have no reason to doubt that it was just as accurate as it was possible for him to superintend.

Q. You would not want to give a percentage of accuracy, say for Dearborn street?

A. No.

Q. Do you think you were within 20 per cent. of the true volume of flow?

A. Oh, I imagine it was within that percentage, all right.

Q. Would you say the same as to Loomis street?

A. I imagine as you went further down stream that the accuracy might be greater than at Dearborn street.

Q. Why at Loomis street?

A. Well, it is further away from the lake and less subject to sudden fluctuations in the lake level.

Q. What effect would that have other than to decrease the rate of flow?

A. Well, these sudden impulses coming from the lake, I have an opinion do not give an accurate discharge throughout the whole section, but simply have an effect on the meter that is not necessarily felt throughout the entire discharge section. That is my opinion.

Q. Did you have some of these sudden impulses at the time of these tests?

A. Why, the water surface, as I remember, varied three or four-tenths in a short space of time, the lake level; and Dearborn street is, I think, just about a mile from the lake.

Q. What influence in your opinion would .2 or .3 change in the elevation of the lake have at Dearborn street?

A. I would not know, but I think it has an influence, all right.

Q. Well, then you do not claim a high degre of accuracy in the work at Dearborn street?

A. It is as accurate as we could get under the circumstances, I think, and from a comparative standpoint, showing how long it took to increase this flow, it ought to give a result that would have some value in determining how long it would take to change the flow from 4,000 to 10,000 cubic feet.

Q. I am speaking of the volume of flow at the particular station?

A. How is that?

Q. (Question read as follows: "Well, then, you do not claim a high degree of accuracy in the work at Dearborn street?")

A. What do you mean by "A high degree of accuracy"? Then I can answer your question. Your idea and mine might be different as to what a high degree of accuracy is.

Q. Would you say within five per cent.?

A. I would not say it was closer than five per cent. It might be.

Q. Did I understand you to say awhile ago you would not say any better than 20 per cent.?

A. No, you did not understand me to say that. You asked me if it would be within 20 per cent., and I said I thought it would be.

Q. Between five and 20; do you have any further opinion?

A. It might be less than five, might be more.

Q. What is your idea as to the degree of accuracy at Loomis street, then?

A. Oh, I would not say. It might be within 5 per cent., might be more.

Q. What is your best judgment as an engineer, if you have any, as to that accuracy?

A. I would say I am not enough of an expert in the use of current meters to say how accurate they are. I simply have to judge by my general information.

Q. In the report made to you by the men that you had doing the work, did they give an opinion as to the accuracy?

A. Not that I recollect. I simply talked with Mr. Blanchard. My recollection is that he stated that the work was as carefully done as he knew how to have it done. These men were competent as far as he knew, the men that were in charge of his party, and that the results were as good as could be expected.

Q. You don't know what Mr. Blanchard's opinion as to the percentage of accuracy, say at Dearborn street is, as to the volume of flow?

A. No, I don't know, as he never expressed that to me.

Q. Mr. Blanchard was not personally present at Dearborn street, was he?

A. He was part of the time.

Q. What part of the time?

A. I don't know. I know that I was there with him at one time.

Q. What time was that?

A. That was on the day of the first test, I believe, along in the middle of the day sometime; possibly in the afternoon; I have forgotten, along maybe two or three o'clock, I should say.

Q. Now, what were the weather conditions on that day, on February 22nd?

A. The weather conditions were, it was quite cold.

Q. In fact there was a blizzard that day, wasn't there?

A. It was a bad day, yes. I think there was quite a snow storm.

Q. There was ice floating in the river?

A. There was some ice in the river, yes, sir.

Q. And you were not satisfied with the work that day so you made another test on March 8th?

A. No, I would not say that exactly. We did it more as

a check, and also on account of the test not being as long as we thought we could get on the second day.

Q. Do you think that the temperature of the water had any effect on the flow?

A. I would not be surprised if it did.

Q. Have you ever made any tests to determine in open rivers whether it makes any difference whether the water is cold or not?

A. It is my opinion from what I have observed on the canal that it does not flow as readily when it is cold as when it is warmer.

Q. What do you think that is due to?

A. Well, it is pretty hard to say, unless it is due to the fact that the water is a good deal lighter,—has the same tendency as molasses, and does not run as well when it is cold as when it is warm.

Q. Do you think fluidity is affected by cold?

A. I am of the opinion that it is.

Q. Just from the fact that it does not seem to flow as fast in cold weather as it does in warm?

A. That is all, and from what I have read in regard to flow of water through filters, over weirs.

Q. Would you take that into consideration in working out any engineering problem?

A. It might be taken into consideration, and I would regard it in this way: We are apt to have a flood come as we did on December 25, in cold weather, and the water would not flow as readily then as it would if we got a flood in June.

Q. If you were working at a particular problem, what effect would you give to the difference in temperature?

A. I do not know. I do not know as that has been determined; if it has I am not familiar with it.

Q. What was the temperature of the water on February 22nd, then?

A. I do not know. It must have been around freezing, anyway.

Q. Did you take that fact into consideration in estimating the flow through the power house and the dams at Lockport?

A. No, I don't know as there is any data available that would give you that. I know on this test we flowed over 10,000 cubic feet according to the records at the power house.

Q. Suppose the water had been at a temperature of 70

degrees under the same conditions, how much more do you think would have flowed?

A. Well, you would get more. What you actually lose is the slope; and it takes more slope, in my opinion, to get the same volume of water through the Chicago River and the Drainage Canal when the water is around 32 to 40 than it does when it is around 70.

Q. Do you have any opinion as to the amount of that difference?

A. Under what conditions?

Q. As between 70 degrees, and about freezing?

A. That would depend upon other things.

Q. What other things?

A. Oh, the amount of water being flowed.

Q. Assume that the other things are the same?

A. Well, then, this would vary with them.

Q. Do you know of any formula for the flow of water in open channels, where the temperature is an element?

A. There may be such a formula, but I have not seen it.

Q. Are you familiar with the formulae of flowing water in open channels?

A. I am familiar with some of them.

Q. Do you not think that most of that effect is due to the ice?

A. No, I do not.

Q. What effect do you think the ice had on February 22?

A. On what?

Q. The discharge, flow of the water?

A. I think it had a tendency to require more slope to get the water through the channel than it would have if the ice had not been there.

Q. That is a greater loss of storage?

A. It means that there would be more water drawn off in storage, yes; that is, more water that you might call storage in the channel would be drawn off.

Q. It would take longer for the effect to be shown, too, wouldn't it?

A. The effect of the—

Q. Take a certain distance, it would take longer for the effect to be shown?

A. Of the full discharge, to get a uniform discharge through the channel?

Q. Or increasing a discharge, take longer to have the effect felt?

A. So that you have a uniform flow through the channel from one volume to another?

Q. Yes?

A. Why, it would, to the extent of the difference in storage due to more head or slope being consumed in flowing the water if it is cold than if it was hot, or warm.

Q. That was in regard to ice, just the effect of ice in the channel?

A. I think my answer is intelligible.

Q. Regardless of the temperature of the water; I mean the floating ice?

A. You would not have floating ice in the water, unless the water was cold.

Q. I understand, but suppose it were just above freezing in both cases; in one case you have ice floating; in the other you do not?

A. There would be a little more slope, I think, due to the fact that the ice projecting above the water has more air friction than just the water surface; and possibly hitting against the sides of the channel. I imagine that there might be some theoretical effect requiring more slope through a long channel than if no ice were there, with the same temperature.

Q. Suppose there were a slope of five feet in the canal, what would be the difference in the volume of flow if the water were 70 degrees in one case and 32 degrees in another?

A. I would not know.

Q. Do you think it would be 5 per cent.?

A. I would not hazard a guess. It would not have any value to the court.

Q. There was quite a strong wind, too, on February 22nd, wasn't there?

A. At times, as I remember.

Q. From what direction?

A. We may have that information, but I do not remember right now.

Q. Have you got it before you?

A. No, I haven't anything before me. I asked you yesterday what you wanted, and you would not tell me.

Q. Did you give it consideration in giving your opinions formerly on the stand?

A. In what respect?

Q. Any respect?

A. Why, I gave it this consideration: I knew it was a very disagreeable day for men to work and to be exposed,

and that was one of the reasons why we carried on a second test. I rather expected that that might be brought up in cross-examination, so as to make this test appear as though it had no value.

Q. So that that was something that you did anticipate?

A. I rather expected that.

Q. Was that one of the reasons why you undertook a new test on March 8th?

A. That was one of them.

Q. Did you consider that the wind would have any effect upon the results as far as flow is concerned? That is in addition to the matter of cross-examination?

A. I know that wind has the effect of changing the elevation of Lake Michigan, for instance, and that it affects the flow through the Chicago River. Of course these current meters were installed at these different stations and were read continuously, and very great care was taken to get as accurate results at that time as was possible by the use of current meters.

Q. Did it have any effect as to the placing of your boat when you were measuring in the sections, where you were measuring from a boat?

A. The only place we measured with a boat on February 22, was at Summit, and the boat was tied tight in the middle of the stream, and held as near stationary as was possible, and I am informed that the boat was practically stationary all the while.

Q. What boat was at Summit at that time?

A. The Robert R. That is the boat that you gentlemen went down the canal on the other day.

Q. You had already determined the coefficient?

A. At Summit?

Q. At Summit?

A. That was done later.

Q. Who did that?

A. Mr. Blanchard did the coefficient work.

Q. Taking March 8th, do you have any more definite opinion as to the accuracy of the measurements at Dearborn street of the volume of flow?

A. I imagine that the ones on March 8th, should receive the benefit of any discrepancy between the two. The weather conditions if they had any effect at all were better, and I know that men work better and more efficiently when they are not exposed to such hardships as they were exposed to

on February 22 which, unfortunately, was a rather severe day and night.

Q. I believe you stated you thought the work was more accurate the further down the canal you went?

A. I am inclined to think so, other conditions being equal; and any effect such as the sudden variations, or variations in the lake level being obscured.

Q. Was there any snow on the ground on March 8th; not thinking of melting ice or snow on the sides?

A. I am speaking from memory; my recollection is there was not much snow on the ground. There was not much, if any, run-off due to thawing.

Q. You would consider the work at Willow Springs, Lemont and Lockport, fairly accurate, then?

A. I would pick Lemont as probably more accurate than the station at Lockport.

Q. Why?

A. Oh, it was a little closer to the dams, and we had done more work at Lemont and the section was probably better understood if I can use—

Q. You think the coefficient work was better determined there?

A. I would say so.

Q. And your cross-section?

A. I don't know about the cross-section, but probably with all the measurements, where we made a great many, better results could be obtained at Lemont than at Lockport.

Q. What is your idea as to the percentage of accuracy at Lemont?

A. I haven't any.

Q. What was the object of putting in the Lockport section?

A. I was anxious, while carrying on this experiment, to get as many sections along the river and channel as we had meters available, and as checks one on the other.

Now, in regard to the accuracy, I can only state that, take Willow Springs, Lemont and Lockport, and taking the storage into consideration, they check one with the other within five per cent. Whether there was an error all on one side or not, I don't know. That is approximately so, as I remember.

Q. How close did Willow Springs and Lockport check, taking into consideration the storage, say at one o'clock P. M.?

A. My recollection is that I would want time to figure that over, if you desire it accurately.

Q. Will you refer to your charts, if you have them?

A. The effect had not got to Willow Springs at that time.

I would like to state right there, it was very hard at that time when the discharge is changing very rapidly to get an accurate result on that. Possibly if you would go along further in the day I could do better, Mr. Hopkins.

Q. Give the best result you can there, approximate it?

A. I want to say that the discharge as indicated graphically is almost a vertical line at one o'clock, and you could make a great big error one way or the other if you did not pick that off. It is not a fair question, at that particular time; and I think Mr. Shenehon would agree with that statement if he would look at the flow in the discharge measurement at Willow Springs at one P. M. on March 8.

Q. You have a chart which you submitted that purports to state the flow at Willow Springs at that time, have you not, Mr. Wisner?

A. It indicates the flow graphically at that time.

Q. Wouldn't it give it within two or three hundred cubic feet?

A. It might not, as anyone could see by observing the chart that at one o'clock the flow is increasing so rapidly at Willow Springs that when it is platted the line is almost a vertical line.

For instance, the flow increased from 12:45, say to 1:10, from 4,600 cubic feet to over 7,000 cubic feet per second.

Q. Well, take 1:30?

A. At that particular time, 1:30, this change was being felt very much at Willow Springs, and the results would not be as good as later on, when the flow had become more nearly uniform. And I can only say that the Lockport discharge measurements checked with the storage run-off within about nine per cent.; Lemont, about one per cent.; and Willow Springs, where the change was then taking place very rapidly and the gages changing, as near as we could figure it was around twelve per cent.

Q. You understood my question was as to Willow Springs and Lockport?

A. That is the only way I can answer that question. Oh, you did not care for Lemont?

Q. It was not in the question.

A. Pardon me; you can cross that out if you wish.

Q. Willow Springs and Lockport check very closely, do they not?

A. I would not say, at that time. Figuring between the meter and the storage, there was a difference at Willow Springs of 12 per cent. and at Lockport of 9 per cent. at that time, when conditions were not good for making a comparison of that kind.

Q. Between the two there was a difference of 3 per cent.?

A. The difference between the measured flow at Willow Springs and what you would compute for the run-off of the storage was 12 per cent., and at Lockport 9 per cent.

Q. Were they on the same side?

A. The error was on the same side.

Q. So that as between the Lockport section and Willow Springs, there was three per cent. difference?

A. I don't know whether that follows or not. I could not say off hand, but possibly that was right.

Q. Now, what are the actual figures there from which you got that per cent.?

A. I just picked them off of this chart, and they may not be exactly accurate, but the measured discharge at Willow Springs, as I used it, was 7,250 cubic feet per second and the storage should have been 8,400. And at Lockport there was a measured discharge of 8,850, and the storage run-off should have been around 9,700. Of course that is assuming that the power house measurement is correct, and taking the difference in elevations as near as we could get it, and there were probably some inaccuracies in getting the gage readings at the same time, although we tried to get them as accurately as possible. But those errors are always bound to creep in in all measurements of this kind.

Q. Do you think that any inaccuracies or errors in the discharge measurements along the canal were as likely to be on the one side as the other?

A. That I do not know. We used all care in having the meters rated before and after, and of course these measurements did not extend over a great number of days and I would not venture an opinion as to whether they are as apt to be on one side as on the other or not.

Q. Do you know of any constant error that was in it?

A. No, I do not know of any constant error that was in this work. The only thing is that at Lemont where we had done more work, it checked better.

Q. Did you make a computation as to the one o'clock time, including storage? Awhile ago you expressed an opin-

ion that that was not worth so much, but did you make any computation?

A. I was judging that from the chart itself, Mr. Hopkins, where the line of discharge is practically vertical, so I did not make any computations at that time.

Q. Will you do so as nearly as you can get it, getting the flow from Willow Springs to the power house?

A. No, I will not, because it would not be a fair answer, and I could not give anywhere near an accurate answer.

Q. How near could you get?

A. It might be away off, at that time.

Q. Have you tried to see how it would come out?

A. No, I can tell by inspection. These show the way these are platted.

Q. Will you figure what it is at one o'clock from Lockport gaging station?

A. Figure what?

Q. What the flow would be at the power house and controlling works, taking into consideration the storage?

A. What is running through the power house is indicated by the flow, and at one o'clock it was 10,350 cubic feet per second approximately.

Q. I ask for an answer to the question?

A. If you will word your question so that I understand it, Mr. Hopkins, I will be glad to answer it, but you asked what the flow was at the power house considering the storage.

Q. Computed from the Lockport gaging station as measured by the current meters?

A. The flow at the Lockport discharge section was a little over 8,500 as I read it from the chart or diagram; between 85 and 8,600 cubic feet per second.

The flow at the Lockport section was 8,600 cubic feet per second, and there was a storage run-off in addition to that, which would be indicated at the power house, of 734 cubic feet per second, bringing it up to 9.334 cubic feet per second and the flow as indicated at the power house was about ten thousand three hundred and something, three hundred and fifty.

The difference would be the error which would probably be less than ten per cent., but anyone can figure it.

Q. Will you take now two o'clock?

A. At the same place?

Q. At the same place?

A. It checked within between 7 and 8 per cent.

Q. What was the amount?

A. The amount as indicated by the power house and controlling works discharge was 10,400 cubic feet per second.

Q. My question is as to the amount from that computation, that is what I am trying to get at, the amounts and not the comparisons.

A. Read me the question.

Q. I want the amount of discharge at the power house and controlling works as computed from the Lockport gaging section, taking into consideration the storage at two o'clock P. M.

A. The only figuring that I have made on the storage has been to assume that the flow through the power house and controlling works is correct. And the answers I have given have been based upon that, when I have taken into consideration the storage.

Q. Isn't there another way to get the storage, and a better way?

A. The storage—

Q. From the difference in elevation of the gages?

A. The storage is figured that way, but in figuring back and comparing one with the other, I have used the discharge at the power house as being correct.

Q. That was not my question.

A. Then I have not understood your question, Mr. Hopkins. I have tried to.

Q. Do you think you understand it now, do you get the point?

A. No, I do not.

Q. (Question read as follows: "I want the amount of discharge at the power house and controlling works as computed from the Lockport gaging section, taking into consideration the storage, at two o'clock P. M.")

A. The discharge at the power house is 10,400 cubic feet per second. The measured discharge at Lockport was 8,950 cubic feet per second, and the storage run-off was 520 cubic feet per second bringing the corrected discharge at the power house up to 9,470 cubic feet per second based upon the Lockport discharge.

Mr. Hopkins: I move to strike out the first sentence as to what the discharge was at the power house and controlling works as not being responsive to the question.

Mr. Adcock: For the record, I should say that that sentence was entirely responsive. I have been listening to the question and answer, and I can't see but what it is responsive.

Mr. Hopkins: Q. Will you give us the computed discharge at the same place at three o'clock?

A. The measured discharge at the Lockport Section was 8,850 cubic feet per second, and the storage run-off was 520, bringing the discharge based upon that section at the Controlling Works up to 9,370, whereas the discharge as recorded at the Power House and Controlling Works was 10,500 cubic feet per second.

Mr. Hopkins: I move to strike out that part of the answer from "whereas" as not being responsive to the question.

Q. At four o'clock?

A. The measured discharge at the Lockport Section was 8,900, and the storage run-off below there was 550 cubic feet per second, bringing the total up to 9,450 cubic feet, but as measured at the Power House it was 10,300 cubic feet per second.

Q. Wasn't that 500 feet storage, rather than 550?

A. We add 550 in our computations.

Q. In your opinion within what degree of accuracy is that storage?

A. I have never figured that. I imagine the storage as computed was fairly accurate.

Q. Is that within five per cent.?

A. Oh, I think so.

Q. Now, take five o'clock?

A. The measured discharge was about 8,720 cubic feet per second. The storage was about 500, bringing the total up to 9,220, and the discharge at the Power House and Controlling Works was a little over 10,000 cubic feet, 10,080 cubic feet per second.

Q. Now will you give us the mean of those five hours, of the computed value?

A. As a mathematical proposition you add up those five discharges and divide them by five, which gives you about 9,370 cubic feet per second.

Q. Now will you make the same computations using Willow Springs instead of Lockport, beginning at one o'clock?

A. The average from two o'clock until five—

Q. Will you give each hour first?

A. At two o'clock it was 9,154 cubic feet per second basing the flow on the measured discharge at Willow Springs at two o'clock. At three o'clock, 9,625 cubic feet per second. At four, 9,570 cubic feet per second. At five, 9,560 cubic feet per second.

Q. What were your two items at five o'clock?

A. The two what?

Q. The items that make up that 9,560 at five o'clock, what was the discharge and storage?

A. The discharge was 7,900 cubic feet per second and the storage was 1,660 cubic feet per second.

Q. Isn't that storage, from your charts, about 1,600?

A. It varies somewhat, but I took it from figures from which the chart was made up.

Q. That shows 1,660?

A. That shows 1,660, yes.

Q. A little short of 1,600, on the chart?

A. I took these from the actual figures from which the chart was made.

Q. Wasn't that discharge at one o'clock at Willow Springs as measured 6,400?

A. That is hard to tell whether it was or not. It is not a fair thing to put that in there.

Q. Isn't it so on the exhibit which you put into this case?

A. The exhibit is an exhibit here, and any one can look at it. I only have to say that is not a fair—

Q. Will you look at it and see what it is?

A. It is not a fair thing to put that in because the water had not gotten to anywhere near a state of evenness of flow. (Referring to Wisner's Exhibit 14e.) The change was just being indicated at Willow Springs, and it would be impossible to get an accurate discharge at a particular time from a plat of this kind. I might make a mistake of seven or eight per cent. in reading off the chart.

Q. Was your current meter running at one o'clock at Willow Springs?

A. My information is that it was.

Q. Do you have the results showing what discharge was indicated at that time?

A. That indicated discharge was probably incorrect at that time.

Q. Then are there any other incorrect data in these exhibits that have been put in evidence?

A. Due to this particular fact, that there was an impulse traveling along the channel; that is simply my opinion. It is probable that the current meter indicated a discharge at the particular place where it was, but it is also probable that this would not give the true discharge, using this point as an index point, and afterwards computing your verticals and figuring

your coefficients. And this probably accounts for the errors in the measurements of the Great Lakes.

Q. How many other incorrect matters are there in those exhibits in your opinion?

A. There is no incorrect information in the exhibits.

Q. You seem to think that that one is incorrect?

A. Assuming that the discharge is as you stated 6,400 cubic feet per second, the storage is 3,191 and it brings the total discharge up to about 9,600 cubic feet per second.

Q. Well now, that is simply on the assumption that is made. Do you pretend to say whether or not that assumption of 6,400 is correct?

A. When the discharge is changing so rapidly, it is hard to pick out what the actual discharge was at a particular second or minute.

Mr. Adcock: Q. As I understand, Mr. Witness, your point is that at that time the line on that chart which shows the discharge was running practically vertical, is that correct?

A. Yes, sir.

Q. Whereas at other points it is more or less of a horizontal line?

A. Yes. You can pick with some degree of accuracy from the chart what the discharge was. As a matter of fact the indicated discharge at Willow Springs by the meter was 6,610 cubic feet per second, whereas this chart, in trying to read it, I read 6,400, as did Mr. Hopkins, which would bring that answer that I gave up 210 cubic feet higher, bringing the discharge up to 9,710 cubic feet per second.

Mr. Hopkins: Q. What was your storage, again?

A. 3,190.

Q. Wouldn't that be 9,590?

A. Pardon me, I read off the wrong number; 9,590.

Mr. Adcock: That is the first figure?

A. That is the first figure.

Q. The corrected figure?

A. The corrected figure would add 210 cubic feet per second to that, bringing it up to 9,800 cubic feet per second.

Mr. Hopkins: Q. What was the method of that correction?

A. That was the actual discharge as indicated by the meter at one o'clock.

Q. According to your plats, Mr. Wisner, your storage is about 3,000 instead of 3,190, isn't it?

A. Well, it would be read, as I stated, on account of this

line being so vertical, anywhere, so that you could get from probably 3,000 cubic feet up to 3,300 cubic feet per second.

Q. At one o'clock?

A. At one o'clock, taking the chart that I have here in front of me, yes, sir.

Mr. Adcock: Q. Why did you take 3,190?

A. I took that from the figures that we had.

Q. That is that shows the actual—

A. Those were the figures from which we attempted to plat this graphical representation of it.

Q. And the chart is made entirely from those figures, as I understand it?

A. Yes.

Q. There might be an inaccuracy of plotting?

A. Very apt to be; where you are trying to read two vertical lines, having only a slight angle of inclination one with the other, the width of the ink stroke would make an inaccuracy in reading.

Q. How do you get 3,300 from that chart?

A. Those two lines practically coincide from 7,000 cubic feet per second or even less up to about 7,400 cubic feet per second. And you could read it anywhere within that 400 cubic feet per second. On the chart, the width of the ink mark overlaps the other line.

Mr. Adcock: Q. Now you have taken the figures—

A. I have taken off of that the figures from which this chart was plotted.

Mr. Hopkins: Q. You attribute the discrepancy between the chart and the figures to errors in plotting?

A. There is no discrepancy. You cannot plat a line that has any thickness. The definition of a line is a thing that has one dimension.

Q. In all of the answers that you have given, the figures for storage are somewhat greater than they appear on the chart?

A. I would not say so. You may read them smaller. I doubt if any two men would take this chart and read it just the same. They might by accident.

Q. With the exception of this one at one o'clock at Willow Springs, didn't you read them all yourself as less than the amount of the figures we asked you awhile ago?

A. I don't remember that I did.

Q. Do you know any reason why any discrepancy in plat-

ting would always show that the storage in the plot is less than the storage from the figures?

A. I don't think that it would.

Mr. Adcock: Q. How much is the difference, as a matter of fact, of the percentage?

A. It would not amount to anything.

Q. Would it show materially on the line?

A. In this particular case, Mr. Adcock, where this line is practically running up and down, it is apt to be considerable, but at other places it ought not to amount to much in percentage.

Mr. Hopkins: What is the mean of your five hours at Willow Springs?

A. The mean is 9,542 cubic feet per second.

Mr. Adcock: Q. That is the computed at the Power House?

A. From Willow Springs to the Power House.

Mr. Hopkins: Q. So you consider it unfair to use the one o'clock at Willow Springs, although it has been put in evidence?

A. Possibly the word "unfair" is wrong. I should have said—

Mr. Adcock: I object to that question, the expression "although it has been put in evidence"; it is absolutely unintelligible. The question has been asked and has been answered. The witness gave the reason.

Mr. Hopkins: Q. Although the data from which the question has been asked has been put in evidence by the defendant in this case?

A. What is the question?

Q. (Question read as follows: "So you consider it unfair to use the one o'clock at Willow Springs, although the data from which the question was asked has been put in evidence by the defendant in this case?")

A. Possibly the word "unfair" is not a proper word to use, but as I stated before, the change was taking place so rapidly in the discharge at Willow Springs as indicated at the Index Point that it was pretty hard to get the actual discharge at a particular minute.

Q. What is your mean of your four, from two to five inclusive?

A. I think that is in, Mr. Hopkins, 9,480.

Q. How does that check with your Lockport computation, the figure you gave for the Lockport for the mean was 9,370.

A. One showed 9,370 and the other one 9,520.

Q. And the mean of those two is 9,450, isn't it?

A. I have not figured it.

Q. Will you verify that? What is the mean of those?

A. 9,455.

Q. What is the difference in percentage from the mean to each of these, the Lockport and the Willow Springs?

A. The difference would be the same.

Q. Difference in per cent. from each one to the mean?

A. Oh, a little less than 1 per cent. based upon the mean as the—

Q. Three-quarters of 1 per cent.?

A. Nine-tenths of one per cent.

Q. And the difference between the two would be about twice that in percentage?

A. One is as far from the mean as the other in percentage, and in figures.

Q. Then these two sections check within two per cent. Is that so?

A. I just said so.

Q. Now you seemed to think that the Lemont gagings are more accurate than the others. Why?

Mr. Adcock: I object to that question, because he has already stated several times in the record why he considered the Lemont gagings were more accurate.

A. More measurements had been made at this section, and I think that possibly on that account the work would be more accurate there.

There is this particular thing, which I think Mr. Shenehon will appreciate: We were rigged up there for making discharge measurements and the work was probably more accurate than any of the other stations.

Q. How did your coefficient compare with the coefficient as determined by Sherman Moore?

A. It checked.

Q. Did you use his coefficient, or did you determine one independently?

A. Determined one independently.

Q. How close was the check?

A. Only by platting. We did not have the actual figures, but by the platting the vertical curves checked.

Q. What was the coefficient used by you in this measurement?

A. .914.

Q. Did you have the data showing what Sherman Moore's coefficient was?

A. We got that by comparing his observed velocity with his corrected velocities, and as near as we could tell it was .91.

Q. How did your cross-section check with Sherman Moore's?

A. I don't know as you could tell exactly on that, because one was taken on one side of the bridge and the other on the other side of the bridge. There might be some variation so that you could not tell in percentage what the variation was, but generally as I recall, it checked very closely.

Q. Might not that have an effect, cause an effect on the coefficient if you took a different section?

A. I should think it would be very slight. That bridge is not, I should say from recollection, over 40 feet wide. This bridge spans the whole channel, part of it being, as you know, in the channel.

Mr. Adcock: Q. That is there is no obstruction at that point?

A. No obstruction from the bridge.

Q. Is it in the rock there?

A. It is in the rock section. The sides are practically vertical.

Q. And the bottom is uniform?

A. Practically level, yes, so built.

Mr. Hopkins: Q. Just what particular advantages did you have at Lemont that you did not have at Lockport and Willow Springs in the way of time, men, equipment and so on?

A. At Lemont, for instance, there was a bridge spanning the channel, and at Lockport we had to rig up a wire trolley across the channel.

Q. And at Willow Springs?

A. Willow Springs had the same advantage, but at Willow Springs the wide earth section was just entering into the narrower rock section. The work had been gone over, quite a number of discharge measurements had been made at Lemont, and this was not so at these other stations.

Q. How far below the beginning of the rock section was the Willow Springs discharge section?

A. I am speaking from memory; I should say five or six hundred feet.

Q. Then what effect do you think that would have, the fact that you were that near a little wider section?

A. It means that when the water got to Lemont, it had been flowing through what you might call a practically uniform section from Willow Springs to Lemont, a distance of approximately eight miles. And it would seem as though the water would have a fairly even flow throughout the section, other things being equal; whereas, this funnel shaped opening into the narrower channel might cause some eddies and it might affect the discharge measurement; but the principal thing is that we did more work at Lemont and were fitted up for it at this particular station better than at any other place.

Q. Did you do more coefficient work or more sounding?

A. Yes, I think both of them.

Q. Were there any eddies at Lockport?

A. Personally I did not see that section. I do not know as there were any eddies, but it was rather close to the Bear Trap Dam and as I stated before there was not a bridge at this place. The work had to be done from the stream itself.

Q. How far from the Bear Trap Dam was that?

A. About 3,000 feet, but the channel starts to widen out about 2,500 feet above the Bear Trap Dam.

Q. With the dam open that distance below, and the canal beginning to widen, that would really facilitate the flow, wouldn't it at Lockport? If it had any effect at all, wouldn't it make it easier?

A. I was talking about the accuracy of the discharge measurement, not about the facility of the flow in the channel.

Q. Why did you choose these sections?

A. We wished to get down as close to where the channel widened out as possible.

Q. Even at the expense of inaccuracies?

A. Oh no, I would not say that. That is an unfair question.

Mr. Hopkins.: Not that it makes any difference, but I do not think it is the province of the witness to comment on the character of the examination. If the attorney wishes to say anything to the court, that is his business. Outside of the record, he can say all he desires to.

Q. In your opinion as a hydraulic engineer, what percentage of inaccuracy could come or did come from the selection of these sections, one about five or six hundred feet below a somewhat wider stretch of canal and the other one about, say the same distance above a wider section?

A. I have never given that any thought. I would not want to answer that without going into it.

Q. Do you really think that it made any difference?

A. I am of that opinion.

Q. Weren't they very good sections for discharge work, both of them?

A. I would say they were better than those that you got on the Niagara or the St. Clair River.

Q. How were your measurements made at the Power House and the Controlling Works?

A. Those were simply made I think, as I testified, by the amount of water flowing over the dams and from the rating of the amount of water that flowed through the wheels. This was based upon the tests made upon these wheels at Holyoke, Massachusetts. The wheels acted practically as a meter.

Q. What was the temperature of the water when those tests were made?

A. That I do not recall.

Q. Do you know the time of the year?

A. They were made at different times.

Q. I believe you testified on your direct examination that those measurements at the Power House and Controlling Works might be inaccurate as much as 10 per cent.?

A. I said they might be. I did not know.

Q. How did you measure the water over the dams?

A. That is by a weir formula which was developed in this office to fit that shape dam as near as we could tell from experiments that had been made at other places.

Q. What is your idea of the degree of accuracy of that?

A. If I recollect, these were checked by some rod float measurements made in the channel.

Q. At what point in the Chicago River does the sewer nearest Lake Michigan empty?

A. I think at the foot of Michigan avenue. There may be some smaller ones east of there coming from concerns located along the bank of the river.

Recess to 2:15 P. M.

June 16, 1914, 2:15 P. M.

GEORGE M. WISNER resumed the stand and testified further on cross-examination as follows:

Mr. Hopkins: Q. Mr. Wisner, in comparing the computed results this morning of Willow Springs with Lockport, do you think that it is better to make the comparison without using the one o'clock reading at Willow Springs?

A. Well, as I said before, the discharge is changing so rapidly at Willow Springs that it might be very difficult to get what the actual discharge was there at some particular minute. Most of these discharge measurements, as I understand, extended over about five minutes' duration.

Q. What would be your computed mean, omitting the one o'clock computation at Willow Springs?

A. 9,480 cubic feet per second.

Q. What do you think of the accuracy of the Robey street measurements as compared with the accuracy say at Willow Springs and Lockport?

A. The section there was not quite as good as at Willow Springs. It was measured off of a boat and undoubtedly was not as good as the measurement made at Lemont.

Q. How about as to Willow Springs and Lockport?

A. The section is better at Willow Springs than Lockport, and any variation in the level of Lake Michigan would affect the discharge measurement more at Robey street than it would at Willow Springs or Lockport. Willow Springs, as I stated before, was measured off of a bridge. Lockport was measured from a cable and Robey street from a boat.

Q. Do you think that the Robey street measurements are as accurate as the others?

A. I would say not as accurate as Lemont. In regard to the others, I would not know because we just made these measurements on those two days, and there were not enough of them made to show the relative accuracy of the measurements.

Q. Do you think there was any constant error at Robey street, so that it would be over or under the others?

A. I would not have an opinion on that.

Q. Do the men who made the measurements, and who are present in the room, have any opinion on it? I understand you are testifying a good deal from their data, so just consult with them.

Mr. Adcock: Of course it is understood, I believe, that Mr.

Wisner's direct examination should show the names of the different persons who had to do with the measurements at different points; and I believe I stated to counsel for the Government that we would produce any one witness, or all, for cross-examination, if the Government wished to ask them any questions.

Mr. Hopkins: As I understood, it was suggested that Mr. Wisner, the Chief Engineer, should give the results of the entire test for all of them; but as to certain details, in fact all of the details, he seemed not to be familiar with; and Mr. Blanchard, who had charge of the field work, is present here, as well as Mr. Ramey, and my suggestion is that the witness get these matters of accuracy, which he does not have any opinion on himself, from these gentlemen.

Mr. Adcock: Yes, the understanding being that we could better facilitate the inquiry into the facts by that method.

A. In reply to the last question, the section at Robey street is not as good as at Willow Springs or Lockport. There was more coefficient work done at those two sections than at Robey street or Loomis street.

Q. Do you think that that would make the result at Robey street less or more than the others?

A. I think the chances are that it might make it less. The further away you get from the outlet, any error that you make in computing the storage would be accumulated.

Q. How about the accuracy of the measurements at Loomis street?

A. The same general criticism would hold in regard to them as at Robey street, uneven bottom, not as good a section, the bottom being soft and hard to get the area, which did not obtain in the rock sections.

Mr. Adcock: You mean hard or harder to get the area?

A. The bottom is softer and it is harder to get it, for the reason it is difficult to locate the surface of this rather soft mud which accumulates in the bottom of the Chicago River.

Mr. Hopkins: Q. A little difficulty in getting the exact cross-section?

A. I would say so, in the Chicago River.

Q. How is Dearborn street?

A. Dearborn street would be the same way, and then that is obstructed somewhat by the bridge.

Q. There is a great deal of storage between Dearborn street and Robey street though, is there not?

A. Not so much.

Q. The North Branch and the South Fork and the slips, the turning basin?

A. On the superficial area, you would be right, but there is not much of a drop due to the storage being drawn off. There is some storage, of course.

Q. Do you think the Dearborn street working results were as accurate as at Loomis street or Robey street?

A. As I stated before, I think the results at Dearborn street may have been affected and were more affected by fluctuation in Lake Michigan than were the others as you went down-stream.

Q. Now similarly to the method used this morning, will you compute the discharge at the Controlling Works and Power House from the Robey street measurements, taking into consideration the storage?

A. At the same hours?

Q. Beginning at two o'clock?

A. We will begin at one o'clock, why not?

Q. Beginning at two o'clock?

A. I am going to begin at one.

Q. I insist upon an answer to the question.

A. I will put your two o'clock in. At one o'clock, it was 10,000 cubic feet; two o'clock, 8,574; three o'clock, 9,285; four o'clock, 8,920; five o'clock, 8,800.

Mr. Hopkins: Now you will read please the question to the witness, beginning at two o'clock. I move the one o'clock be stricken out as not responsive to the question.

Mr. Adcock: You have prepared figures similarly, have you not?

A. To what we were asked this morning at the other stations, yes. Two o'clock—

Mr. Hopkins: As I understand, no one in this case contends that any effect would be felt from the Power House to Robey street within one hour. I do not think any one has any justification for that except facetiousness.

The Witness: You can read the answer, what it is in there from two o'clock on .

Mr. Hopkins: Q. Will you give us the means of those computations from two to five inclusive?

A. About 8,900 cubic feet per second for those four.

Mr. Adcock: Q. You are leaving out the one o'clock?

A. Yes.

Mr. Hopkins: Q. Do you think there is any greater percentage of error in the storage as shown at Robey street than the others?

A. I would say so, yes; much more.
Q. In percentage?
A. Yes, in percentage, quantity or any other way?
Q. Why?
A. Well, from Willow Springs down, or to Lockport and to the Power House on the other side, the walls are practically vertical, whereas above there the side slopes, and the slopes have caved in some and we have no accurate way of telling just what the area is—we have not as accurate a way of telling what the area is as the water gets lower.
Q. Would that fact make your storage too big or too little?
A. It might make the storage either way; might make the error either way.
Q. Will you give us the same computed values computed from Loomis street, from two to five inclusive?
A. The average or mean for that is about 8,250 cubic feet per second, the average of the four.
Q. That is Power House and Controlling Works now, computed from Loomis street?
A. Yes.
Q. What is it for two o'clock, three, four, five?
A. Two o'clock, 7,677; three o'clock, 8,265; four o'clock, 8,560; five o'clock, 8,520.
Q. I presume you would not expect anything like as accurate results at Dearborn street by that method of computation as at the other places, because of the greater storage and length of time?
A. Well, the greater storage, and the further fact that as you get up to this end of the works, the beginning of the channel, a slight error in the reading of the gages would make quite a large percentage error in the amount of storage drawn off, and then Dearborn street, as I stated before, is affected by variations in lake level.
Q. Just how much difference in the accuracy, percentage of accuracy of storage do you think there is between say Willow Springs and Robey street?
A. It would simply be a guess on my part, and there is no way that I know of—
Q. Where you have no sloping sides, and slope washed in, one way or the other.
Mr. Adcock: Mr. Witness, you may finish your former answer before answering that question.
A. (Answer of witness read as follows: "It would simply be a guess on my part and there is no way that I know

of—") —of accurately or anywhere near accurately estimating how much more accurate one is than the other; but I can say that in the earth sections which have been washed considerably by the passage of boats, it might make quite a little difference. We simply had to figure this on the theoretical section as built. We have no additional data, and it was an approximation of the amount of storage above Willow Springs, more so than below.

Mr. Hopkins: Q. Could you give any outside limits, when you say it would be a mere guess?

A. No, I would not attempt to do that as it would be, might be misleading.

Q. The canal is about 200 feet wide at the surface along through there, isn't it?

A. There is one stretch of it that is 202 feet wide on the bottom, with side slopes. The other was built 110 feet wide on the bottom and side slopes of two horizontal to one vertical. A part of that stretch has since been widened, I think about 70 feet.

Q. So that a few feet variation on the sides from place to place would not make very much difference in the storage?

A. It might make considerable difference when you consider the long distances and also further, as I stated, that any little inaccuracy in the reading of gages at this end, would amount to considerable.

Q. Do you think it could be ten per cent. in error?

A. I would not hazard a guess. You are just as well able to guess on that as I am.

Q. To what extent then has it washed, or changed its capacity?

A. There are places where the canal has probably widened at the surface, the water surface width is 40 or 50 feet wider than we dug it.

Q. Possibly at other places it has caved in?

A. And narrowed?

Q. Yes?

A. At the water surface? I think not.

Q. Do you think it would average 40 feet?

A. No, I don't think so.

Q. Do you think it would average 10 feet?

A. I imagine it would average more than that.

Q. Do you figure that in getting the storage?

A. No, we figure the storage and the theoretical widths as actually dug. We did not have the other measurements,

Q. Would you consider that there is an average of 20 feet?

A. I would not guess on that.

Q. Well, that possible error could not do much more than account for the difference as computed say between Robey street and Willow Springs, could it?

A. Well, taken in connection with any gage readings that were not accurately made, there might be a considerable error there.

There was one other thing that might affect the storage, I am informed by Mr. Ramey, and that was that he did not include in these storage quantities the water that would drain down from the North Shore Channel.

Q. That would only affect the computations from Dearborn street, would it not?

A. That would not affect it except at Dearborn street.

Q. There is no reason why the storage as given in these charts or in your tables there in the Rock Section should be on one side rather than the other, larger or smaller than the correct amount, is there?

A. If there is, I do not think of it at this time.

Q. In other words, you do not have the canal widened at the surface as you had it in the earth section?

A. No, except to a small percentage.

Q. Is there any constant error that you know of in that storage as submitted by you in your direct testimony?

A. I do not remember that I submitted it in my direct testimony.

Q. It is in these exhibits?

A. On those exhibits, yes.

Q. (Question read) "Is there any constant error that you know of in that storage as submitted to you" in the exhibits from which you testified in your examination, copies of which were submitted to the Government for examination, as showing the results of those tests, referring to plate 34A.

Mr. Adcock: I do not know that those were offered in evidence.

Mr. Hopkins: I said which were submitted. I offer in evidence chart 34. Is there any objection to it? If so I will try to identify it by the other people. Let it appear that 34A is a chart submitted to the Government by the Chief Engineer of the Sanitary District, the witness, as showing certain results obtained in tests made under his direction March 8 and 9, 1914; and is attached to and to be taken in connection with Wisner's Exhibits—

Mr. Adcock: They were not attached to it. The exhibits which we offered in evidence are bound together.

Mr. Hopkins: Do you object to the admission of this chart in evidence, the one which has been submitted to us, or shall we ask the man who made it—

Mr. Adcock: It has not been the custom to object on those grounds?

Mr. Hopkins: With the idea of reserving the objection. I do not want it to come later.

Mr. Adcock: No, I understand there is no reserved objection as to any question of form. It is only objections as to substance that are reserved in this testimony.

Mr. Hopkins: Q. Mr. Wisner, will you refer to Table 34A, and tell us what that is? By whom was it made and tell us what it shows.

A. It was made under my direction by Mr. Ramey and it shows that assuming the discharge at the Power House and the Controlling Works as correct, and substracting from that the storage drawn off between the different points, shows what the discharge would have been at the other stations as indicated on the plat, Lockport, Lemont, Willow Springs, Robey street, Loomis street, Dearborn street.

Q. How were these various values for storage derived?

A. By taking, as I stated before, the area of the surface, and how much the water was reduced in elevation between the gages; that is for instance if the water was reduced a foot in height from Willow Springs to Lockport, we took the length times the width, times I foot, and that gave the number of cubic feet that the storage was reduced in a certain time.

Q. Is that a correct chart, correctly plotted and so on?

A. I presume it is approximately correct.

Mr. Adcock: Q. That is as near as you can plot?

A. As near as we can plot.

Q. And I also understand Mr. Witness, that you have the figures here from which that plot was made, and those were among the various things we offered to produce for the benefit of the Government upon request?

A. That is correct.

Mr. Hopkins: I offer that chart in evidence as Wisner's Exhibit 14G. of this date.

Whereupon chart identified was marked Wisner's Exhibit 14G, June 16, 1914.

Q. Now Mr. Wisner, the discharge at the Controlling

Works and the Power House, showing an average of 9,370 from one until five, as computed from the gage readings at Lockport, and the storage from Willow Springs an average of 9,480 from two until five, Robey street 8,950 from two to five, and Loomis street 8,250 from two to five, taking into consideration your former statement that the measurements at the Controlling Works and the Power House may be in error ten per cent., is it now your opinion that the gage readings at Lemont are nearer correct than all the rest of these?

A. I take it you mean discharge measurements at Lemont.

Q. Yes.

A. I would say so Mr. Hopkins.

Q. Then all the rest are out of step but this one?

A. I would rather base my judgment upon the measurements made at Lemont.

Q. Although there is consistently a lower amount at the other four stations?

A. That might be, but there were more measurements made there, and the work was really more carefully done for the reason we were making discharge measurements there for another purpose, and Mr. Blanchard was employed particularly to make those measurements as accurately as it was known how to make them.

Mr. Adcock: That is the other measurements?

A. At Lemont.

Mr. Hopkins: How about the others, wasn't he to make those as carefully as possible?

A. Yes, but there were only a few of them made; and if I understand work of this kind, you have to make a great many measurements in order to get at a fair discharge for a stream of this kind.

Q. Do you know any reason why all of these should show so much lower than Lemont?

A. No, I do not, unless possible sewage coming in from the sewers at this end may have had some effect, and we did not get it as storage when it was really storage or supply.

Q. How many sewers are there coming in below Robey street?

A. There is one at Western avenue, a big sewer at Western avenue and this one at the Corn Products Company; that is a big one; a big one at Kedzie avenue, and maybe some others.

Q. How many below Willow Springs?

A. There is quite a little leakage comes in from the Des

Plaines River. I do not know of any sewers. There may possibly be some further down but I do not recall them now.

Q. How much in cubic feet per second do you think comes in between Robey street and Lemont in sewers?

A. I never measured it.

Q. How much came in during this particular test, have you any idea?

A. No, I do not know.

Q. Would it be 1,000 cubic feet per second?

A. No, I doubt it.

Q. Or 100 or 10?

A. Oh, it would be more than 10, probably more than—I am merely guessing—I should say there was more than 100 cubic feet per second, a great deal.

Q. That could not account for the difference?

A. No, that might simply be accounted for in the inaccuracy of getting the correct area of the storage or the measurements may be in error. They were simply made on these two days.

Q. What kind of a meter did you use at Lemont?

A. I think that is all in the direct testimony. I am willing to put that in again if you want.

Q. Yes, I want that.

A. Haskell meter at Lemont.

Q. At Lockport you used a Haskell meter?

A. Haskell at Lockport.

Q. A Price meter at Willow Springs?

A. Yes.

Q. As far as the meter work is concerned, there is no reason why Lemont should be any more accurate than the other two?

A. Not as far as I know as regards the meter itself, except the inconvenience of handling it. It was much more convenient at Lemont than at Lockport.

Q. You did not have any inconvenience at Willow Springs?

A. No, but at Willow Springs that was another kind of meter. Willow Springs, as far as the section was concerned, the convenience of handling the meter was concerned, and Lemont were practically the same.

Q. Then you consider the Haskell Meter gives better results than the Price Meter?

A. I am not an expert on that, Mr. Hopkins.

Q. You mentioned the fact that they were different meters?

A. They were.

Q. Is that supposed to have had any effect on the results?

A. That I would not know.

Q. If you are not sure that your gagings were accurate or any of the discharge measurements were reasonably accurate, then your test is not worth quite so much, is it?

A. I did not say that I was not sure that they were reasonably accurate. You said that.

Q. What do you say?

A. I say considering what was done, I think the work was well done and with a degree of accuracy that you would expect under the circumstances.

I further say that the work at Lemont was the best work, and should be entitled to more credit than the others.

Q. Although it is out of harmony with four others, omitting Dearborn street because of the difficulties there, though it is out of harmony with four others you still insist that was the best result?

A. It is out of harmony but, I explained, to a reasonable extent.

Q. When you speak of "well done," can you give us some idea from which we can judge that in figures or percentages, either in cubic feet per second or any other way, so that we know what it means?

A. In making measurements of the kind that we made to get comparative results where sections, discharge sections were not continuously measured over a long number of days, I would say if on one measurement on one place and another one at another place, if they agreed within 10 per cent. with some place that was accurately made, you would be doing work pretty carefully, because the law of averages does not enter into offset errors that may come into a measurement of this kind; and there were only a few measurements made at any station except at Lemont.

Q. Lockport, Robey and Willow Springs agree much closer than 10 per cent., do they not?

A. They may. I have not figured within what percentage they do agree.

Q. Will you refer to your chart there, at six o'clock—

A. Which chart do you refer to?

Q. I think it is your 14e, as introduced in evidence. Will

you compute the amount at the Controlling Works and the Power House from Lockport, at six o'clock?

A. A little over 10,000 cubic feet per second.

Q. How about Willow Springs?

A. Basing it on Willow Springs?

Q. Yes, basing it on Willow Springs?

A. That is a little over 10,000 cubic feet per second, too.

Q. Take the same two stations at seven o'clock?

A. Based on Lockport it is 10,750, and on Willow Springs, 10,950.

Q. Doesn't that look as though there was quite an increase in the flow between five and six o'clock at the Power House?

A. There was an increase in the flow at the Power House as indicated between 5:30 and 6:30, of about 400 cubic feet a second.

Q. And the flow at Lockport and at Willow Springs shortly thereafter conforms very closely to it, does it not, in those computations, taking into consideration the storage each time?

A. I do not quite understand, Mr. Hopkins, what you mean when you say conforms very closely to it.

Q. To the flow as shown on the Power House and Controlling Works line?

A. I would not say that it conforms very closely to that; probably off 600 or 700 cubic feet a second right there.

Q. Does it not take into consideration the storage?

A. We were taking into consideration the storage.

Q. But it is much closer than it was from one o'clock to five o'clock, is it not?

A. I would have to plot that on here to see that. I do not remember what those figures were at one o'clock, now.

Q. From one to five for Lockport was 9,370, an average. Take your average?

A. Well, generally between one and five there is a little more discrepancy than there is from seven to eight or nine o'clock in the evening. That is assuming that the records at the Power House were correct.

Q. About 5:30 you were changing from your Bear Trap Dam to your turbines.

A. Yes, that is true.

Q. Is it not possible that more water would get through the turbines than you estimate, and that there may be an error in the amount as determined at the Power House between one and five?

A. I think undoubtedly those wheels are underrated in

the amount of water they take. That is particularly so, Mr. Hopkins, working under a low head.

Q. At what time were you working under the low head?

A. The head had gotten down pretty well at five to six o'clock in the evening, and from then on until the end of the test.

Q. Don't you think it is possible that the amount shown on Chart 14e, for the Power House and Controlling Works between one and five o'clock was too high?

A. It checks very closely with the Lemont measurements up to five o'clock.

Q. But in all cases it is more than the Lemont measurements, is it not?

A. The discharge at the Power House?

Q. Yes?

A. Is more than the Lemont discharge?

Q. Yes?

A. From one to five? Yes.

Q. As computed with the storage, too? That is taking into consideration the storage.

A. Well then, taking into consideration the storage from one o'clock until five, the two check very closely. For instance at one o'clock, taking the storage into consideration, based upon Lemont, the discharge is 10,400, and at one o'clock from the records it was 10,350 cubic feet per second.

At two o'clock, the records at the Power House show a discharge of about 10,400, and computed from Lemont it is 10,200. At three o'clock it checks within about 300 cubic feet per second. At four o'clock, within about 200 cubic feet per second, and at five o'clock it is about 50 or practically the same.

Q. There is a sewer you say at Michigan avenue?

A. Yes.

Q. About how much does it discharge in cubic feet a second, an average?

A. I would have to look that up for you, Mr. Hopkins. I do not know now.

Q. How much during the time of this test on March 8th?

A. I suppose we could get some sort of an estimate but I haven't it in mind.

Q. What is the total amount of sewage that goes into the canal, or that discharges from sewers?

A. In dry weather it is about 250 gallons per capita.

Q. Can you give us that in cubic feet per second?

A. As near as we can tell from the gagings we have made, the dry weather flow amounts to about 300 gallons per capita. This includes seepage that comes into the sewers, and on that basis, if my calculation is right, the total run-off would be in the neighborhood of 1,150, between 1,150 and 1,200 cubic feet per second.

Q. How much of that is below Robey street, between Robey street and the Power House?

A. I do not know. I could not answer that offhand, Mr. Hopkins.

Q. About 10 per cent.?

A. There is a big sewer comes in at Western avenue. I do not know; I would say offhand I do not think it amounted to 10 per cent.

Q. How was that flow distributed; is there much of it between noon and midnight, is that when most of it comes, or vice versa?

A. With the long sewers, it takes a longer time, and with the short ones a shorter time to get to the river.

Q. What proportion of that 1,150 cubic feet per second comes into the North Branch of the river?

A. I would have to look that up. I could not answer that offhand.

Q. Can you give roughly what it is?

A. I would not think there was 30 per cent. of it. I may be in error; I am simply guessing.

Q. How about the South Fork, the Stock Yards?

A. There is quite a big population drains into that.

Q. As much as 40 per cent., you think?

A. I do not want to go into this and then be checked up on the percentage. If you want a table prepared, I would be very glad to do it.

Q. I thought perhaps you could get it roughly. Have you got the information where you could get at it and give us this more or less offhand or approximately correct?

A. That would take some little time to get it approximately correct.

Q. There is a very small percentage of that amount coming into the river between Lake street and the lake, is there not?

A. I would not say there is very much that comes in between Lake street and the lake, although there is a big run-off, dry weather run-off from the so-called Loop District. In fact it is more than the storm run-off.

Q. Where does that go into the river, south of Lake street?

A. Pardon me, I thought you said between Lake street and the lake.

Q. Yes. I just wanted to know where it goes into the river?

A. It goes in at all the streets, I think there is a sewer on every street from Michigan over to Lake street.

Q. Is there a sewer running on the east and west streets?

A. There is on some of them. I am not sure about all.

Q. Lake, Randolph, Madison, Washington?

A. There is a big long sewer on North Clark street that comes in from the north. At Randolph street, my recollection is there is not a very large sewer on the east side of the river.

Q. Now what is the area of the watershed of the Chicago River?

A. My recollection is it is 307 square miles.

Q. 307. Just in a general way what are its boundaries?

A. Well, it goes from Lake Michigan west to the ridge between the Des Plaines River and the Chicago River.

Q. How far north?

A. It goes north away up into Lake County.

Q. Skokie?

A. The Skokie is all in that drainage area, yes, sir.

Q. And how far south?

A. Well, it goes south practically the whole length of the Drainage Canal, you might say, but that was not included in those figures. As I remember, those figures only go down as far as Summit.

Q. How far south along the lake?

A. We divide that where the sewers come north from the Calumet River, that is about 87th street.

Q. About how often in the course of a year would there be a storm of 10,000 cubic feet per second?

A. That would depend upon the year.

Q. Contributing to the canal. Take an average year.

A. That is a rather difficult question to answer, for the reason that the number of days in the year that this will happen will increase as this drainage basin becomes more filled up and improvements are made by which the water, for instance from the Skokie drains off faster; but I would say that you might get a maximum a flood here of 10,000 cubic feet per second possibly on an average of once or twice a year through a number of years.

Q. How long would that rate of flow last?

A. That would depend upon the stream. They had one in 1892 in May, and one in June, that lasted for several days, as I recall it. We have had them since then where they kept up, as near as I can recall, two or three days. When I say that, I do not wish to be understood as meaning that there was 10,000 cubic feet all the while, but it was a heavy run-off. The discharges were not measured.

Q. And in order to have that big a run-off, that rainfall has got to cover a large part of the drainage area, has it not?

A. I should say that you might have what you call a local storm and still cover that area, which is not very large.

Q. I know, but what I have in mind is you could not get a 10,000 cubic foot run-off from just the territory adjoining the Chicago River, within a mile or two of it each way?

A. I would say probably you could. When I make that answer, I have in mind that there was a local storm of that kind, which I think I testified to, which occurred on Hickory Creek, which is a stream that runs into the Des Plaines River at Joliet. I presume it is nowhere over 40 miles from the City of Chicago, and at places closer. That storm occurred, and it flooded out the City of Joliet, went over the railroad tracks at that time where the Santa Fe depot was located. Since then the tracks have been elevated. And at that time there was a heavy rain storm in the City of Joliet itself, but it occurred east and north of the City of Joliet, and did not, according to information that I had at the time, cover a very large area.

Q. What is the area of the City of Chicago?

A. I think it is 195 square miles.

Q. Of course the Desplaines River and the river valley is not included in this 307 square miles?

A. No.

Q. Did you ever know of a case where you had 10,000 cubic feet of water in the Chicago River from a storm, where the rain did not cover more than 100 square miles?

A. I haven't any data of that kind, Mr. Hopkins. No, that would be almost impossible information to get, as to just how much a severe storm would cover. My opinion would be that if you have a rain storm that would produce 10,000 cubic feet per second, it would probably cover the whole of Chicago River. It would be raining in all parts of the district except in a particular case like I mentioned that happened around Joliet. As I understood, you asked me if

that were possible to occur, and I have stated this particular thing which occurred within 40 miles of Chicago.

Q. In other words, then, it would take longer than the two or three hours that you mentioned in your direct testimony for the full 10,000 cubic feet of water to get in the Chicago River, that is, the South Branch of it, and the canal, because you have got to give time for some of it to come in from the suburban districts, have you not?

A. I think it would be entirely possible for it to get into the Chicago River within the time stated in my direct testimony.

Q. What is the shortest time, not possible but probable, as the existing conditions are in this community, when a storm of 10,000 cubic feet a second would get into the South Branch of the Chicago River or the canal?

A. That would depend entirely upon the condition of the ground and previous rains, amount of snow upon the ground; whether the ground was saturated or not, and general conditions of that kind?

Q. What is the shortest time that you could get 10,000 cubic feet into the river from a rain storm in the ordinary course of nature, not just a possible downpour?

A. I think the range I gave in my testimony would be the shortest time.

Q. What was that?

A. My recollection was, I can look those notes up, but I think it was three to four hours, as I remember it.

Q. How did you determine that?

A. We just determined that from measurements we had made on different sewerage districts or sewers, one of which was located on the North side, one upon the Southwest side and one down on the South side.

Q. What test did you make?

A. Took the time when the rain started and when we got the maximum run-off from the sewers and from that we made an estimate as to how long—

Q. Where did you make your measurements of the run-off in the sewers?

A. At the outlet.

Q. Where were these outlets located, say on the North side?

A. The one on the Southwest side was at Robey street, the other one was at 39th street pumping station, and the other on the North side, Diversey boulevard, I believe. We

took these three separate districts, so as to get a kind of general idea what would happen in the whole city.

Q. Then your determintion was how long it would take to get into the Chicago River, including its various branches?

A. No, that was when it would be poured into the Chicago River like for instance you pour several streams into a bowl and it was overflowed and it would start to run out.

Q. This time of three or four hours, where did you get the water to in that time?

A. That is from the time the rain had gotten a good start until we got the maximum or concentrated high load.

Q. At the mouths of the sewers?

A. Yes.

Q. And at various distances from the South Branch to the Drainage Canal?

A. Well, Diversey boulevard empties into the North Branch.

Q. How far is that from the lake by way of the river?

A. Diversey boulevard?

Q. Yes?

A. That sewer must be three or four miles north of the river, and the river is about a mile and a half long; three and a half miles north and a mile and a half over.

Q. About five miles?

A. Yes, about five.

Q. Robey street is how far, seven miles?

A. That is about six miles from the mouth of the river.

Q. And the 39th street outlet?

A. Well, that is pumped into the 39th street conduit and it comes into the river at Halsted street.

Q. 39th and Halsted?

A. 39th and Halsted.

Q. Was that where you made your measurements in this case?

A. No, we measured it as it came into the pumping station.

Q. On the lake?

A. On the lake, yes, sir.

Q. Around by way of that pumping station to the lake is about ten miles at least, isn't it?

A. It may be in the neighborhood of eight or nine miles.

Mr. Adcock: Q. Around to the lake?

A. Yes, from the pumping station around.

Q. What has that got to do with it?

A. Nothing.

Mr. Hopkins: Q. It takes some time for water to go seven miles even if it were going towards the lake, doesn't it?

A. Yes, sir.

Q. And even after you got it into the river, it would take it some time if it were flowing towards the lake, would it not?

A. Yes, sir.

Q. To what capacity can you open up the Controlling Works and the Power House at Lockport, both of them, the whole works at the Power House?

A. That would depend on how high the water was at the Power House and the Controlling Works.

Q. Assuming a mean discharge of 4,167 cubic feet a second?

A. That that has been flowing right along steadily?

Q. Yes?

A. Assuming also that the lake is normal. I suppose we could open up for a short time, you might get a large flow. I would not attempt to say what it would be without computing it. And it would be some little job to do that, but I doubt if you could flow over 14,000 for a very short time.

Q. Haven't you got some blank spaces in the old Controlling Works that could be opened up and make it more?

A. Oh, we could knock out the end of the canal, and for a short time you would get a larger flow than 10,000 cubic feet per second, but it would not last very long unless the rest of the channel were enlarged.

Q. At those places at the power house reserved for a lock, if a dam were put in there, you could let through 20,000 or more, could you not, if you had the water there? I am speaking of the capacity to flow it through there?

A. I know, but the point is simply this, you might temporarily have a large flow there, but could not keep it up any length of time.

Q. Because you have not got the water there to run through it?

A. You would not have the water there. I have often said when people have brought up the question of flooding at Joliet, if the Controlling Works broke, what damage it would do, and I have been of the opinion it would not do much damage. It would simply soon draw itself down and you would not be able to get through the channel any more water than the capacity of the channel.

Q. What capacity could you open it for at that end?

A. I am trying to tell you, at the start you might be able to get 20,000 cubic feet a second through for a short time, but it would gradually decrease on you.

Mr. Adcock: Q. For how long?

A. I would not attempt to say; it would be simply a guess and figuring on the storage. I have not figured it.

Q. It would be a very short time?

A. I should say so.

Mr. Hopkins: Q. As far as what would become of water that is contributed along the canal, you would have your slope down so that any water contributed along the canal would go with that?

A. That would go with that, yes.

Q. You would not need to be actually flowing 20,000 at that end, if you have the capacity for it, that would throw what water you got that way, would it not?

A. I don't think you made that clear to me.

Q. (Question read.)

A. You mean I could create a hole in the reservoir and let it fill up down there? You could do that for a short period, but I think it would be some considerable time, if that is what you are getting at, before you could get 10,000 cubic feet of water going through the Chicago River at Robey street.

Q. Through the Rock Section, you have a capacity of 14,000 cubic feet?

A. Yes.

Q. Above that you have a little—

A. That is assuming, Mr. Hopkins, that the rest of the channel above there has been improved to the same capacity.

Q. That is what I was going to ask you about.

A. Yes.

Q. You are starting some dredging around Summit now?

A. We have been dredging there, yes.

Q. You are widening the canal there?

A. Yes, sir.

Q. To what width?

A. We are widening it, I think it amounts to about 50 feet.

Q. And that makes it what capacity?

A. I do not know that.

Q. Take the entire canal from Robey street, what is the maximum amount you can flow through?

A. I have never tried to flow the maximum amount through it for any considerable length of time except in times of

storm to prevent the water from the Chicago River from going into the lake, and there the source of supply was rather general.

It is pretty hard to tell what the maximum capacity of that channel would be if we would open it up real wide. The best evidence we have are these tests you have seen here where we flowed 10,000 cubic feet for some ten hours, as I recall.

Q. Then what will be the dimensions of your canal at the narrowest place, when you get through with this dredging?

A. This is merely a progressive dredging. The intention was to take off at this time just sufficient to provide the dilution water for the present population; and at some future time to widen still further.

Q. What is the dimension now at the narrowest point?

A. The narrowest point there now is 110 feet wide on the bottom, 2 to 1 side slopes.

Q. How deep, 26 feet?

A. No, I think about 24.

Q. You are going to widen that 50 feet on one side or both sides?

A. My recollection is about 50 feet on one side.

Q. That will make it 160 feet wide?

A. About that, yes, sir.

Q. And 24 feet deep?

A. Yes, sir. I would like to qualify that answer a little bit as to width. Before when the channel was dug, it was dug in the dry and the sides were sloped up two horizontal to one vertical. When you come to dredge it, you cannot make a slope of that kind, and we have simply dug into the bank on the north side of the channel about 50 feet and come up pretty near straight with the dipper bucket; the result being that when you get through you hardly have available 50 feet additional width that we are dredging, because the ground above the water surface is some 14 or 15 feet high, and that caves in and takes up the available cross section for the free flow of water.

Q. The cross sectional area would be over 5,000 square feet would it not?

A. In reply to that, I would say the cross section, taking into consideration the caving, I doubt if it would be much over 4200 square feet.

Q. It would not be a very difficult matter to get a section there of 5,000 cubic feet?

A. It is a matter of expense. You could get one of 20,000; it is not difficult.

Q. It would not be any very great expense to make it 5,000 from what you have now with a similar amount of dredging, say, on the other side?

A. If I make those figures right, it would probably cost in the neighborhood of $130,000 a mile.

Q. You mean to widen it to that extent?

A. To widen it, yes.

Q. This dredging that is going on now on the North side, is costing that much?

A. It is costing more than that.

Q. What are you doing with the dirt?

A. It is being used on public improvements, filling the lake front park, building the piers out here for the new harbor that the City of Chicago is building, and in front of which the United States Government is to build a break water.

Q. What is that dirt worth?

A. It is a liability as far as we are concerned.

Q. But is considered in getting rid of it in that estimate you made?

A. I was assuming that it was taken away and placed in the lake somewhere.

Q. Now if you had 10,000 cubic feet of water from the Government, you would still want this channel widened to the extent of digging it through there, wouldn't you?

Mr. Adcock: I object to that question, as the assumption is improper and also impossible. The Government already has the water.

Q. (Question read.)

A. You would want to have the channel of a large enough capacity to get the 10,000 through.

Q. Whether you had 10,000 cubic feet a second or not, if you could help keep water out of the lake in flood times by increasing the width of the canal, it would probably be wise to do it, would it not?

A. I do not think you could maintain it, Mr. Hopkins.

Q. Then why is it being widened now?

A. So as to get water through it.

Q. The same way with the Sag Canal that is being dug, it is going ahead increasing the expenses regardless of the determination of the water rights?

A. That is hardly an engineering question, is it?

Q. Now suppose you did have the canal widened all the way to accommodate a flow of 10,000 cubic feet a second, and

you were to open your Controlling Works to between 14 and 20,000 cubic feet a second, wouldn't it draw off the storage much more quickly in the canal?

A. Oh, that would draw the storage off quicker, yes.

Q. So that you would have an increased slope the length of the canal?

A. That would increase the slope. That is what it does.

Q. And any water that ran into the canal or ran in say along Robey Street, Ashland Avenue, all of that neighborhood, would pile up where the elevation is highest and still further increase the slope towards Lockport, would it not?

A. Yes, and it might increase it towards the lake to such an extent that there would be a peak and run both ways.

Q. In three hours you would have your storage in the lower end of the canal practically drawn off, would you not?

A. I do not think so. 14,000 flowing, you mean?

Q. An opening of 14,000 or more.

A. My recollection is that I figured that with 14,000 flowing at the lower end, if it were possible to so stop up the canal that an increased flow would not be coming in from the lake, it would take in the neighborhood of six hours to draw off the storage.

Q. All the way?

A. Yes, that is assuming—

Q. That is all the way to the lake?

A. That is assuming up to Dearborn Street, I believe. I just gave you that, Mr. Hopkins, because I did not have a definite answer to the other one, and I did have that.

Q. What would it be in your opinion about Robey Street?

A. To draw that storage off would take about five hours and 20 minutes; that is assuming that it does not increase any from water that would naturally run in; assuming no flow into the canal from above Robey Street.

Q. That is 14,000 from Lockport up to Robey Street?

A. Yes.

Q. Five hours and 20 minutes?

A. Yes.

Mr. Adcock: That is 14,000 at Lockport?

Mr. Hopkins: Yes.

Q. It takes only 40 minutes from Robey Street to Dearborn Street?

A. Less than that if I have it correct.

Q. Now in three hours, would you not have the larger part of that storage up to Robey Street drawn off? You would have nearly all of it down at the lower end, and the fore bay

and down there and would you not have the larger part up as far as Robey Street?

A. In three hours, you would have about 6/11ths of it drawn off.

Q. You think that is uniform in the length of time?

A. That was your assumption as I understood it.

Q. No, I didn't assume anything?

A. You assumed, as I understood you, in your question that there was a flow of 14,000 through the lower end of the canal.

Q. Open it up to that capacity?

A. Yes. That means a uniform flow, as I understood it, out at the end of the canal, 14,000 cubic feet a second.

Q. Your 6/11ths is the ratio of 3 to 5½?

A. Yes, it is.

Q. Do you think that drawing off the storage is uniform, taking a particular point along the line?

A. No, in answering your question, I understood you to ask me how long would it take to draw the storage off, and I assumed no water would be coming into the canal this side of Robey Street, from the lake or anywhere else, except what was flowing through with the 4167 cubic feet. I assumed that that was a constant.

Q. Would not the storm water itself tend to dam the water that was coming from Lake Michigan?

A. Yes, and carry the sewage out into the lake.

Q. Then it would tend to dam the water, would it?

A. The water coming in—if you can speak of a water dam, which is rather absurd.

Q. All right, you use some other word that will express it. You know what I am trying to get at.

A. I do not mean to criticise you Mr. Hopkins, but as I see it—

Q. If you have then a storm and from six to 10,000 cubic feet of water is contributed to the river along three or four or five or six or seven miles from the lake, would that not in itself tend to stop the water coming from Lake Michigan?

A. The tendency would be for that water to go into the lake.

Q. Do you understand my question? Do you think my question calls for that answer or do you just want to keep reiterating that?

A. I think it does, Mr. Hopkins.

Mr. Adcock: It seemed to me that the answer was responsive.

Mr. Hopkins: I move the answer be stricken out as not responsive.

Q. Suppose then that only 4,167 cubic feet is your storm and it all comes in through the South Fork and runs into Ashland Avenue, where would that go?

Mr. Adcock: When?

A. If you were flowing a constant amount through the lower end of the channel of 4167 cubic feet per second and the water was supplied from the sewers on the South Branch, as I conceive of it the main branch would be at a stand still, providing the lake did not vary in elevation which it usually does in times of storm, and there would not be any water coming in from the lake, if that were possible.

Q. Now suppose that a greater amount comes in at various places along the way, it tends to pile up the storage and would stop water coming from Lake Michigan, would it not?

A. To pile up and run out into the lake, because you cannot—

Q. Would it stop water coming from Lake Michigan?

A. It would if your supply coming from sewers and run-off of the Chicago Drainage area were greater than what were flowing through the channel at Robey Street, then it would stop the supply of it coming from Lake Michigan, reverse the current and go into the lake. I cannot make my answer any more responsive than that.

Mr. Hopkins: You just keep saying something that I do not ask for; you suppose it may be, or it is something else, which I think your counsel can take care of.

Mr. Adcock: May be the witness does not say just what you want him to.

Mr. Hopkins: No, the witness insists on answering something I did not ask him, because he wants to get that into the record.

Mr. Adcock: I do not agree with you on that. It seems to me the witness is following your question very closely.

Mr. Hopkins: Yes, he understands it, but he is answering something else.

Mr. Adcock: No, I disagree with you on that.

I think the record will show.

Adjourned to Wednesday, June 17, at 10:00 A. M.

Wednesday, June 17, 1914, 10:00 A. M.

GEORGE M. WISNER resumed the stand and testified further as follows:

Cross-Examination Continued by Mr. Hopkins.

Q. What is the width of the draw at Michigan Avenue?

A. I can get it for you in just a few moments; I haven't it in mind. The width of the two draws?

Q. Yes, of all the bridges along the river.

A. You want them all?

Q. Yes? The bridge at Michigan Avenue is known as the Rush Street Bridge, isn't it?

A. Yes, that is the one at the foot of Michigan Avenue. I have information before me as to the width of the openings at Michigan Avenue. The width for nagivation in one draw is 72 feet, and in the other one 73 feet.

Mr. Adcock: Which ones?

A. I do not know; they are practically the same. For the passage of water it would be greater, the bridge being askew. That is simply the width of a boat that could pass through this draw.

Mr. Hopkins: Q. What is the width for passage of water?

A. That I haven't so accurately, Mr. Hopkins. In reply to that question, by scaling, which is approximately correct, it is 90 feet in one draw and 84 in the other; and on one side of the bridge there is a by-pass between a pier and the abutment or dock line, which is 7 feet wide on the bottom and about 10 feet wide at the water line.

Q. Does that part of the river which is not used for navigation have the same depth as the other?

A. I would so so, generally. It is simply on account of the bridge going across the river askew, that you can't get such a wide boat through it.

Q. Is that bridge at right angles to the direction of flow?

A. I would say at that particular point that it is, but the river has quite a crook in it. It is substantially correct. The by-pass is on the north side of the river.

Q. Do you know the depth of the by-pass?

A. I do not. I never had occasion to look that up.

Q. What is the width of the draw at State Street?

A. It is 140 feet clear for the passage of boats. That is between protections. There are two by-passes, one on each side of the river, and the opening for the passage of water is a little greater than this 140 feet.

Q. What is the dimension of the by-pass? You have it there in square feet, area of the by-pass?

A. Yes, with the water assumed to be at datum. Of course if the lake is higher than that there will be a little added; 180 square feet in each by-pass.

Q. There is more or less obstruction to the by-pass at State Street, is there not, some piles in around there?

A. I did not notice the other day when I was there whether in front of the by-pass there were piles or not. When we built it, we aimed to keep the piles behind the masonry work, and not in front of the openings to the by-pass.

Q. At these places there is not very much current, is there?

A. Well, we never have a swift current in the river.

Q. Compared to the current in the middle of the river, there is not much current?

A. It is somewhat slower, Mr. Hopkins, necessarily.

Q. What volume of flow do you think passes through those by-passes?

A. I never measured that.

Q. How long has that by-pass been there?

A. Since the State Street bridge was built.

Q. When was that?

A. That is already in evidence on that exhibit that was put in here. It is on these maps if you want to go into that again.

Q. Yes, if you have it before you.

A. It is on that exhibit.

Q. I would like to have that. When was that State Street Bridge put in?

A. 1903.

Q. If there were any piles or other obstruction in those by-passes, that would tend still further to obstruct the flow through there?

A. If that were so that would be true, but there were none left in the by-pass.

Q. Has there been any dredging in the by-pass, since the bridge was constructed in 1903?

A. No, nor in the river that I know of.

Q. So that if there is any filling in, in the by-pass, it would still be there?

A. Unless the current scoured it through. If it were filled in, of course it would be there.

Q. Do you know whether there is any filling there?

A. No, I do not. I have not made any personal examination of that. I know of none having been made.

Q. With the velocities of flow that obtain in those by-passes, is there likely to be any filling up?

A. I should not think so. My recollection is that the sewers are built so as to discharge on the down stream side of the bridge. I doubt if there would be any filling coming from the solids in the sewage. When I say the down-stream side of the bridge, I mean the west side of the bridge.

Mr. Adcock: The west side of the bridge?

A. Being the side away from which the current strikes the bridge.

Q. Some of the witnesses have referred to the down stream side as being towards the lake; others away from the lake.

A. When I refer to down stream, I refer to that side away from the lake.

Mr. Hopkins: Q. Now what is the width at Dearborn Street?

A. It is 142 feet for the passage of boats between protections, outside of protections.

Q. Any by-pass there?

A. Yes, sir, two, each having a net area of 175 square feet.

Q. Are the conditions there as to by-passes the same as at State Street?

A. My same answer would apply to Dearborn Street as to State. I understand that this particular by-pass,—these by-passes have been filled in. That bridge was built, if you wish that information, in 1907, completed in 1907.

Mr. Adcock: You do not know that there is any filling in at State Street?

A. No, I do not know that.

Q. There is no evidence that you have heard of, that there is any filling in?

A. No.

Mr. Hopkins: Q. How do you know that there has been any filling in at Dearborn Street?

A. Because we had that investigated.

Q. You have made soundings?

A. Yes.

Q. Clark Street Bridge is a swing bridge?

A. Clark Street is a swing bridge.

Q. What are the widths of the two draws?

A. 78 feet and 68 feet, for the passage of boats. The open-

ing for the passage of water is practically the same. It may be a few feet wider but I haven't the information.

Q. Now Wells Street or Fifth Avenue. What is the name of that bridge?

A. Wells Street Bridge.

Mr. Adcock: Is that a swing bridge?

A. Swing bridge. The channel width for navigation is 65 feet and 71 feet. My recollection is that there are by-passes there, but I have not the information.

Q. Do you have any idea what their dimensions are?

A. No, I have not, Mr. Hopkins. There may be also by-passes or a by-pass at Clark Street, but I haven't that information. We did not have anything to do with those bridges. Those that we have had anything to do with I can give you accurate information in regard to them.

Q. How about Lake Street?

A. Lake Street is now being removed. Let me correct that; they are now building a new bridge at Lake Street.

Q. What kind of a bridge?

A. Doing away with the center pier and building one of the bascule type similar to the ones at Dearborn and Randolph Streets.

Q. What will be the openings?

A. This bridge is being built by the City of Chicago. It is about 209 feet at the water line and a couple of feet less at the bottom of the channel.

Mr. Adcock: Q. That is the opening for Lake Street?

A. There is a slight batter on the piers at Lake Street.

Mr. Hopkins: Q. Take Randolph Street?

A. It is 141 feet 2 inches in the clear, and two by-passes each of 204 square feet area.

Q. About how much wider in total width would that make it, the 408 square feet additional area?

A. About 25 feet.

Q. What is the depth in those by-passes?

A. About 16 feet as I recall.

Q. Making a total width then not to exceed 167 feet?

A. In that neighborhood.

Q. Washington Street?

A. 170 feet 6 inches.

Q. Any additional opening there?

A. I think not.

Q. Madison Street?

A. Madison Street is a swing bridge, and it has been or-

dered out by the Secretary of War and is to be rebuilt by the City of Chicago as soon as the new bridge now being built at Jackson Boulevard is completed; and is to have a clear opening of 180 feet.

Q. Adams Street?

A. On the west side is an opening 60 feet wide and on the east side about 83, varies from 82 to 85½ feet.

Q. Any by-pass there?

A. There is no by-pass at that place. It is a swing type.

Q. What about the width of the new bridge at Jackson Boulevard?

A. The opening there for navigation would be 168 feet wide and for the passage of water about 174, plus a by-pass area of 384 square feet.

Q. What is the depth of the by-pass?

A. 18 feet.

Mr. Adcock: That is the same depth, that is on each side of the by-pass at the dock line.

A. It will be that depth in front of the by-pass.

Mr. Hopkins: Q. What is the proposed plan for the Metropolitan bridge?

A. That is ordered out by the Secretary of War and is to be removed by the 1st of December of this year.

Q. What is the next bridge below Jackson, Van Buren?

A. Van Buren.

Q. What is the width of that?

A. 98 feet in the clear and a by-pass of 800 square feet.

Q. What is the depth of the by-pass?

A. Minus 17; that would be 17 feet deep with the water at datum. That 98 feet width is for the passage of boats, and there is probably eight feet, 6 to 8 feet more for the passage of water.

Q. What would be the width of the by-pass?

A. It is 50 feet in width and the area is 800 square feet based upon the bottom being at minus 16, but as a matter of fact, it is at minus 17, which would give an area of about 850 square feet instead of the one I gave.

Q. You have got a total width there of not over 156 feet?

A. About 156 feet. That bridge is an old bridge; has been in there since before the World's Fair year.

Q. What is the next bridge, Harrison Street?

A. Harrison Street.

Q. What is the width of that?

A. About 175 feet.

Q. Is there a bridge at Polk Street?
A. Polk Street yes; 160 feet.
Q. Taylor?
A. 140 feet with two by-passes of 137 square feet each.
Q. What is the depth of the by-passes?
A. The bottom of the by-pass is on an incline. It varies at the dock from about 6 or 8 feet in depth to out next the pier where it is about 18 feet.
Q. What is the average width of the two by-passes?
A. 16 feet.
Q. Each?
A. Yes.
Q. At the water surface
A. Yes, sir, at the water surface.
Q. So that the water surface has a total width of 172 feet?
A. That would be right.
Q. How about the other bridges down below, are there any others that are along 175 feet or less for the flow of water, total width? If so what are they?
A. You ask me for any less than 175 feet total width?
Q. Yes?
A. 12th Street, you know there is an old bridge there that is to be removed. It was ordered out.
Mr. Adcock: By the United States Government?
A. By the United States Government.
Mr. Hopkins: Q. What is the width there now?
A. For navigation it is 53½ and 61.3 feet. I think it is somewhat wider for the passage of water.
Q. How much?
A. I do not know, Mr. Hopkins. I haven't that information.
Q. How about the St. Charles Air Line bridge?
A. That is to be re-built by the railroad companies, with 200 foot opening. It is now a swing bridge with two draws. It has openings for navigation of 55½ and 59½ feet.
Mr. Adcock: Q. That is being built, isn't it?
A. They have not started it yet.
Mr. Hopkins: Q. Are there any others of a width less than 175 feet?
A. Halsted Street.
Q. What is that width?
A. That exact information I have not, but it is approximately 120 foot opening and there are two by-passes.

Q. What is the nearest approximation you have to the by-passes?

A. They are about 25 to 30 feet in width.

Q. Each?

A. Each.

Q. You do not know what their cross sectional area is?

A. I haven't that, Mr. Hopkins.

Q. Between Halsted Street and say Rush Street, the width of the river aside from the bridges, you say is about 200 feet.

A. It is 200 feet or more with the exception of four places along the river where the widening has not yet been completed.

Q. Those you have already named?

A. Yes.

Q. How much wider in the wide places is it than 200 feet between Halsted Street and Rush Street?

A. Oh, I presume there are places where it is 400 or 500 feet wide.

Q. Does that include slips?

A. On the main river there are places where it is over 300 feet in width and at the junction of the two branches of course it is over 500 feet wide, the junction of the north and south branch. There are places on the south branch where it would be as wide as 280 feet.

Q. In the season of navigation, boats are lying from place to place along that stretch of the river, are they not?

A. Not very many; very few.

Q. Where do they tie up?

A. Mostly out beyond Rush Street, towards the lake from Rush Street. There are some small boats that go down to the lumber yards, go into the slips. Occasionally you will see a boat tied up in the main river west of Rush Street. On the south branch, once in a while there is one at Randolph Street.

Q. Some passenger boats dock at Clark Street?

A. Passenger boats come up close to Clark Street.

Q. The South Haven boats are on the north side of the river and west of Clark Street, are they not?

A. I do not remember about that.

Mr. Adcock: Q. They are not there for very long at a time, are they?

A. I know generally the most of those passenger boats are west of Rush Street. There are some that come up there occasionally and go out, boats doing an excursion business in the summer time, that come through the State Street bridge I think.

Q. What is the width of the river from Rush Street out, say for the next two or three hundred feet?

A. 300 to 270 feet.

Q. What is the width of the river between Rush and State Streets?

A. It runs around 220 feet, except at one point.

Q. The Goodrich boats dock in there, do they not?

A. I think they do, just east of Rush Street.

Q. Just west of Rush Street?

A. West of Rush Street, no, the Graham and Morton are west of Rush and the Goodrich east.

Mr. Adcock: Q. These passenger boats do not lie at the docks very long, do they?

A. Not ordinarily, no.

Mr. Hopkins: Q. Don't they usually lie in Chicago about 12 hours?

A. I didn't think they were here that long.

Q. Boats that get in early in the morning do not go out until evening?

Mr. Adcock: No.

A. They go out and coal up.

Mr. Adcock: They come in the morning and go out in the morning, make a day trip?

Mr. Hopkins: That is just the excursion boats.

The Witness: They make two trips a day in the busy season.

Q. That is the Michigan City boats?

A. I think across the lake, St. Joseph.

Q. How about the Northern Michigan Transportation line?

A. Where do they go?

Q. They go to Ludington, Manistee, Frankfort, and other northern ports?

A. I don't know. I can't answer; I am not familiar with that.

Mr. Adcock: They only have a few boats here anyway.

The Witness: I do not know how many boats they have, Mr. Adcock.

Mr. Hopkins: Do you have any measurements in the Chicago River showing a greater velocity than a mile and a quarter an hour?

A. Not that I know of. I am speaking now outside of the narrow bridge openings, where bridges have not been—

Q. No, that is what I am speaking of. Have you any measurements?

A. I haven't any measurements there but I believe the current probably in some of those old draws is faster than that.

Q. You have no measurements of them?

Mr. Adcock: For what volume of flow?

A. The only measurements that I have in the bridge openings are those that we took at Dearborn Street when the mean current was about a mile and a quarter an hour.

Mr. Adcock: Q. Was that the mean, or the maximum for the tests there?

Mr. Hopkins: Q. What was the current at your index point there?

A. It was 2.4 feet per second, around about there.

Mr. Adcock: Q. Was that the maximum?

A. That is at the index point.

Q. I know, but when the flow was at the maximum during that test?

A. Just about the maximum.

Q. It was about 10,000?

A. That is what we were flowing through the Controlling Works.

Mr. Hopkins: Q. What was the flow at Dearborn Street at that time?

A. Between 6500 and 7000 cubic feet a second.

Q. Did you just have one section at Dearborn Street and one index point?

A. There was practically just one index point.

Q. Did you take into consideration those by-passes in getting the volume of flow there?

A. Those were taken into consideration.

Q. What is the slope of the canal, when it is covered with ice?

A. I never saw it covered with ice.

Q. Do you have much floating ice in the canal?

A. At times, there is quite a little at this end of the canal; very seldom—

Q. Does it take any more water to flush that out? How do you handle it at the lower end?

A. It never gives us any bother there, except once I think we had a slight trouble, that was one winter a few years ago that was very severe, and at that time we did not have much trouble with the ice. I believe we let down the dam and let it pass over the top.

Q. Where do you measure the amount of water that you are taking through the canal?

A. At the lower end.

Q. Do you take any less water in the winter time than you do in the summer time?

A. I think we do as a general thing.

Q. You have longer periods in the day for lighting purposes have you not?

A. Yes.

Q. How about your head, is it higher or lower in the winter?

A. The water surface is usually lower in the winter than it is in the summer, because the lake rises in the summer time.

Q. But to generate that power, you need more water in the winter?

A. I do not waste as much in the winter though as I do in the summer.

Q. Do your records show that you take less water in the winter time than the summer?

A. I think they do. I am speaking generally now.

Q. How much less?

A. I am pretty certain that was so this last winter.

Q. How much less?

A. I would say 50 or 60,000 cubic feet a minute, may be more.

Q. Why did you take less this winter?

A. Well, it is simply that they were building up their head, as we call it at the lower end, on account of the low water during the winter; and for the reason that we do have a big demand for a short time during our peak load for water. In order to carry through that, we would shut down the flow and would let the water fill up in the lower end of the channel to give us additional head when our peak load came on.

Q. If you had 10,000 cubic feet of water per second, would there be any occasion to take any less in the winter time than in the summer time?

A. It might be advantageous.

Q. It is a question of your convenience down at the power house and the lower end as to how much you would take is it not, between seasons?

A. I don't quite understand what you mean by that question, Mr. Hopkins?

Q. You have control as to how much you would take. It

would be a matter of your own convenience whether you took more or less water any particular time?

A. We have so far had control of the amount of water that passes through the channel.

Mr. Adcock: Q. It is not any matter of convenience?

A. It is not a matter of convenience.

Q. We are contracted to flow a certain amount for the population?

A. Yes.

Mr. Hopkins: Q. Are you contracted to flow more in one season of the year than you are in another?

A. No.

Q. Is it not somewhat a matter of discretion for the people in charge of the works there whether they shall take a little more to-day, and a little less to-morrow?

Mr. Adcock: That is within reasonable limits.

A. I think that would be a good answer, within reasonable limits. I think we should be allowed also some discretion, as long as we conform to the spirit of the law.

Mr. Hopkins: Q. You are speaking of what you call the State law?

A. Yes, sir.

Q. The fluidity of the water then does not make any difference, whether you take more or less in the winter time?

A. It does not up to a reasonable amount. As I told you yesterday, I thought it would require more slope or head to get the same amount of water through the channel when the water is cold than it does when it is warm.

Q. If you were measuring it at Lockport as to how much you want and how much you were going to take, the fluidity would not make any difference would it? You might require a little larger opening if the fluidity had any effect?

A. We might make a mistake in the amount of water we are flowing, by the formula that we have, for the passage of water through these wheels, and to some extent possibly over the dams.

Q. Did you ever take into consideration the difference in the fluidity of the water at different temperatures, in regulating the amount of your flow at Lockport?

A. I never thought that that refinement was necessary.

Mr. Hopkins: I want to state for the record that in view of the fact that there is a motion pending before the court as to the materiality of what has been called the sanitary phase of this question, we reserve the right to further cross-examine this witness, and before the court, in case that point is de-

cided adversely to the Government. We also reserve the right, which has been offered to us, to call the witnesses who actually made these tests, and questioned them as to the detail of the tests and the accuracy of their work.

Mr. Adcock: This seems to be a different plan from that which the Government has followed heretofore. We have put on several sanitary experts, or sanitary engineers, with reference to various questions involved, and the Government has cross-examined upon that point; and furthermore I believe the witness has been cross-examined by the Government with reference to the so-called sanitary phase of this case, about which he testified on direct examination.

Mr. Hopkins: As I understand, there has no witness testified in regard to this feature since that motion has been taken under consideration by the court, and he said that in case that he did rule adversely to the Government he would give permission to introduce evidence.

Also in view of that contention of the Government that it is entirely immaterial, we have not regarded it as necessary to make an elaborate study to adequately cross-examine the witness; and I will say also that the witness' disposition to avoid the questions has something to do with it.

Mr. Adcock: The cross-examination upon that feature has been closed. The witness has been produced on re-direct examination with reference to matters entirely different from that, and has testified in that regard.

The Witness: I rather resent the statement made by counsel there that I have avoided answering the questions.

Mr. Adcock: Just wait a moment: As to the counsel's statement with reference to the manner in which the witness has answered the questions, it seems to me entirely unnecessary; it is an improper statement, and it is not borne out at all by the record. The witness has very carefully endeavored to answer the question which has been put to him, as the record will disclose. And I hope that the counsel's statement is not made on account of any difficulties that might have occurred between the witness and counsel. I assumed that he was above such idea.

Recess to 2:30 P. M.

After Recess, June 17, 2:30 P. M.

GEORGE M. WISNER resumed the stand and further testified as follows:

Re-direct Examination by Mr. Adcock.

Q. You were asked yesterday Mr. Wisner, to compute the discharge at the Power House on March 8, 1914, during the time that the test was made under your direction by the Sanitary District, from the gaging station at Lockport, Willow Springs, Robey and Loomis Streets, taking into consideration the storage for the hours beginning at 1:00 P. M. to 5:00 P. M. inclusive. Was there any condition existing at that time which would make a computation of the discharge at the Power House in those hours difficult, or where there might be inaccuracies creep in? And if so, how would those hours compare with the conditions of flow from 6:00 P. M. until 12:00 midnight?

A. Taking the first hours when a sudden change had been made in the discharge out at the end of the channel from approximately 4167 cubic feet per second to over 10,000 cubic feet per second and this change accomplished in a few minutes, it leaves the whole channel which is 30 miles long, and the Chicago River in what you might call an unstable condition. In other words, this sudden change might set up, and probably does, a pulsation through the canal, and measurements which you get from current meters would probably be unreliable until the stream had gotten into some sort of a quiescent state or a state of gradually increasing its flow. That was particularly so I think, as I pointed out yesterday, as far as one o'clock was concerned at the Willow Springs discharge section, where the change was taking place rapidly; that is the flow was varying rapidly, and to make a comparison on those hours—

Q. You mean the flow or the velocity?

A. The velocity was changing. To make a comparison of those hours, I do not think would be as fair or the results as reliable as though you would pick out say from 5:30 that evening until 1:00 o'clock in the morning when the canal was assuming a state of equilibrium or trying to adjust itself to the changed condition of flow at the lower end.

Q. You stated on your direct examination, I believe, that the flow was changed about noon of the 8th?

A. It was.

Q. From 4167 cubic feet per second at the Power House to something over 10,000 cubic feet as shown by the record there?

A. As near as we could tell.

Q. Have you made any computations, taking into consideration the matter of storage and the flow at the Power House at different hours beginning at 6:00 P. M. until 1:00 P. M. inclusive of that day, the 8th of March, at these various gaging stations beginning at Lockport, and if you have will you state what the results of your computations are and what the flow is at the Power House, as computed from these different stations?

A. I have taken, to be exact, from 5:30 P. M. of that day until 12:30 A. M. the next morning, being seven hours; taking the measured discharge at the Lockport Discharge Station and adding to it the reservoir water that was drawn off at the same time below Lockport, that is for the condition represented at the end of each hour, and for this total time would give an average discharge throughout this period at the power station based upon the measurement made at the Lockport discharge section, which was some 3,000 feet above the old Bear Trap Dam, of 10,749 cubic feet per second.

Q. That is the average for that period?

A. That is the average for that period.

Q. From 5:30 P. M. to 1:00 A. M.?

A. Taking the measured discharge at Lemont and the storage of reservoir water that was drawn off below Lemont for the same period and in the same manner, the discharge at the power house was as computed 11,156 cubic feet per second. Using the Willow Springs Discharge Section in the same way, and taking into consideration the storage or reservoir water drawn off of the canal below Willow Springs, the discharge was 10,899 cubic feet per second.

At the Robey Street discharge section, taking the measured discharge and the reservoir water drawn off, the discharge at the Power House would be 10,386 cubic feet per second.

Loomis Street, treated in the same manner, would be 9,614 cubic feet per second. Dearborn Street, 9,801 cubic feet per second.

The average of all six of these computations is 10,436 cubic feet per second.

Q. What was the mean of the discharge at the Power House as shown by the records at the Power House for that time?

A. 10,117 cubic feet per second.

Q. What per cent. of variation is that?

A. Well, the per cent. of variation from the mean of these six as compared with the record as shown at the Power House is 3.06 per cent.

Q. Taking the various gaging stations, what is the per cent.?

A. The maximum at any place, maximum variation from the mean, at Loomis Street, in the Chicago River, was 7.86 per cent. I would say in that connection if the gaging stations in the Chicago River, the discharge of which is more affected by the variation in level of Lake Michigan, if they were left out this percentage would be closer.

Q. You stated yesterday I believe, that there was some difficulty in obtaining an accurate value for the storage?

A. Yes, sir.

Q. At those stations?

A. That is true.

Q. Loomis and Dearborn Street?

A. Loomis and Dearborn Street.

Q. Do you consider this is a better way to determine the agreement between the records at the Power House and those at the various gaging stations during that test than to take the hours which you were asked about yesterday on cross-examination?

A. I think there is no doubt of it.

Q. For the reasons that you have heretofore stated?

A. Yes, sir.

Q. You were asked yesterday something about the dredging of the channel or the widening of the channel in the earth section, which was done somewhat recently. Now do you know under what contract that is being done and with whom?

A. It is being done under a contract made in 1912.

Q. August, wasn't it?

A. August, 1912, with the Great Lakes Dredging and Dock Company, and at the end of last season's work, which was along in December, as I remember it, the work was practically 80 per cent. finished.

Q. By the first or sixth of October of last year, it was probably about 4/5ths done?

A. Yes.

Q. You were asked about the velocity at the index point during the tests on March 8, 1914, at Dearborn Street?

A. Yes, sir.

Q. I believe you stated that the velocity at the index point was about 2.4 feet per second?

Mr. Hopkins: I understood him to say miles per hour.

The Witness: I did not mean it miles per hour; if I said it that way I misspoke.

Mr. Adcock: Q. Would the mean for the cross section be less?

A. Yes.

Q. You were flowing, the recorded discharge at that velocity was approximately 7,000 cubic feet per second, was it not?

A. Yes.

Q. According to the population of the Sanitary District and the rate provided by law, the flow should be approximately 7,000 cubic feet per second, should it not?

A. 7500 cubic feet per second in round numbers.

Mr. Hopkins: I object to that, "as provided by law." That is a matter of interpretation. Just state it in figures.

Mr. Adcock: Q. As provided by the act under which the Sanitary District is organized, and in which the legal rate of dilution is fixed at 20,000 cubic feet per second for each 100,000 of population.

A. 20,000 cubic feet per minute for each 100,000 population.

Q. Yes. Now at that time you were making a test, were you not?

A. Yes.

Q. Under the ordinary operations of the channel to provide the dilution water which you have mentioned, 7500 cubic feet per second, how much in cubic feet per second of water would be flowing through the river itself?

A. Through the main river at Dearborn Street, I suppose you mean?

Q. Yes?

A. The way we were operating ordinarily would be to have 2,000 cubic feet per second coming through the 39th Street pumping station; and about 1700 cubic feet per second coming down through the North Branch, and the balance through the main river.

Q. So that there would be about 4,000 cubic feet per second of water going through the main river?

A. In round numbers.

Q. And approximately 5500 cubic feet per second through the main river, the south branch and the west fork?

A. Yes, except below Ashland Avenue, Mr. Adcock, where the river from Ashland Avenue to Robey Street would get the entire flow, but the river is much wider there and no bridges.

Q. This velocity which was mentioned, which you observed

and referred to, 1.6 miles per hour at the index point, was taken at a bridge opening, was it not?

A. Yes, sir.

Q. At Dearborn Street. You stated on your direct examination that prior to the opening of the Drainage Channel and the improvements made by the Sanitary District, you saw boats frequently stuck in the river, did you not?

A. Many times.

Q. Have you ever seen any boats stuck in the river since the opening of the channel and the making of the improvements by the Sanitary District and since the tunnels were taken out?

A. My recollection is only twice, once at the Pennsylvania railroad bridge at Stewart Avenue across the South Branch just south of 18th Street; and this was due to the fact that a new bridge foundation was being built in order to remove the old center pier bridge, and it became necessary in the construction of this bridge to build cofferdams out into the river, and the railroad company so clogged the stream that a boat got jammed in the draw.

Q. That was during the period of construction?

A. It was during the period of reconstruction. The other one was at Washington Street, at which time the Washington Street bridge was being rebuilt.

Q. The plans for those two bridges, the plans for the construction of the bridges and the manner of construction and the obstructions that were to be placed in the river while the bridges were being constructed, were approved by the Secretary of War, were they not?

A. There was a permit from the Engineering Officer for certain details in connection with it, and there was a permit for the general improvement, but there were certain details about stopping, likewise, that the Engineering Officer of the United States Army at Chicago granted the permit for.

Q. Now, in these bridges or bridge openings, where bridges have been built or improved under the improved type since the opening of the drainage channel, have you ever seen any boats stuck or damaged there?

A. No, sir, I do not think there have been any.

Q. You stated in the direct examination that the plans of the Sanitary District ultimately anticipate a flow through the Chicago River of approximately 8,000 cubic feet per second?

A. That would be through the South Branch.

Q. Yes, through the South Branch, and the 2,000 at 39th Street Conduit?

A. About 6,000 through the main river.

Q. No.

A. About that; there would be 1700 coming down the North Branch.

Q. That is the way it is now?

A. It will be that way too, if we are flowing 10,000 cubic feet, there will be 1700 coming down the North Branch.

Q. Are these bridges so built that you may dredge the channel of the river deeper, so that the velocities at the bridge openings may be less as may be necessary to increase your flow according to population?

A. They are so built, the foundations are carried down so that you can safely dredge to 30 feet depth at the foundation and deeper in the center of the river; and most of them you can go deeper than that with safety, I believe.

Q. But at the present time, with 4,000 cubic feet, approximately 4,000 cubic feet, going through the main branch and approximately 5500 cubic feet going through the South Branch and the West Fork, is the velocity except at certain restricted places where bridges are being constructed more than a mile and a quarter an hour?

A. No, it is not that much.

Q. It is not that much?

A. No.

Q. What would you say the velocity was?

A. Through the main river, it would be in the neighborhood of not to exceed a foot a second. That is 3600 feet an hour, and a mile is 5280 feet. It would be about ¾ of a mile an hour. In the South Branch, it would be a little less than a mile an hour.

Q. Now, are you speaking of the mean current?

A. Mean.

Q. A question was asked you this morning with reference to the flow of water in the winter time, and the suggestion or inference was endeavored to be drawn from the question asked that you flowed the water according to the demands of the Power House. Is that so?

Mr. Hopkins: I object to the question as stating an assumption.

Mr. Adcock: I am speaking of the mean daily flow?

A. Of the mean daily flow, I would say not. We have varied the flow from hour to hour during the day, so as to neutralize to better advantage power which otherwise would have gone to waste.

Q. In other words, during the winter time there is a peak load that comes on about 4:30, isn't there?

A. 4:30, and lasts until about 7:30.

Q. You endeavor to build up the head?

A. Store the water to use during that peak load.

Q. But when you take into consideration the mean daily flow, that corresponds approximately as near as you can make it, with the requirements according to population?

A. Very nearly. There have been some exceptions to that.

Q. But as a general rule that is true?

A. As a general rule we aim to get as near that as possible.

Q. It is your understanding that in the winter time when the water is cold that perhaps somewhat less water would flow through a particular opening than would flow during the summer time when it is warmer.

Mr. Hopkins: I object to the leading form of the question.

A. That is my opinion.

Mr. Adcock: That is all.

Re-cross Examination by Mr. Hopkins.

Q. Is that opinion you have just expressed based upon any test made by yourself?

A. It is based more, Mr. Hopkins, upon my observation of the amount of head or slope between Lake Michigan and the Power House.

Q. Just what observations have you made?

A. They were more or less general. Without being accurate, I would know that there is a certain amount of power being generated and that the elevation of the lake was so much, and it seemed to require, took more fall going from the lake to the power house than it did in the warmer weather.

Q. But under those conditions wasn't there floating ice in the river?

A. Not necessarily.

Q. Did you ever make observations of that kind when there was no ice in the river?

A. The same thing happens then, but how much of it was to be accounted for by the ice, and how much was on account of the water not flowing so readily, I could not say.

Q. Do you know any way of determining what effect the temperature of water has on the fluidity of it?

A. That would be a hard problem. I have never seen that

laid down in any books, but as I stated before I know it does not flow so readily through sand filters as it does when the water is warm.

Q. There you have smaller openings. You haven't a big wide, free flowing canal.

A. That is true, but the effect is there just the same. I do not mean by that to the same extent, but I mean the general theory.

Q. You do think it is there, leaving out ice effects, that it is there appreciably in the canal?

A. When the water is cold, yes, and by cold I mean the water temperature is from 32 to 41 Fahrenheit.

Q. That is not known in limits of percentage?

A. Oh, no.

Q. Such as 1 per cent.?

A. It would be purely a guess, and I have told you all that I know about it. In cold weather the water seems to take and I am of the opinion that it does take more head or slope in the Power House than when the water is around 60 or 70 degrees temperature.

Q. Regardless of how much head it takes to get it, you can take 10,000 cubic feet of water at the Power House in the winter time or the summer, can you not?

A. When we get this improvement finished, I think we can. I doubt if in the winter time we could flow 10,000 cubic feet under all conditions.

Q. Can you under all conditions in the summer time now?

A. I think we come closer to it. I would not say that.

Q. What difference between the two, as it is now?

A. What difference between what, how do you mean?

Q. As to whether you can get 10,000 in the summer time and in the winter time?

A. I have never tried to flow 10,000 for any length of time in the summer time when there was not a big run-off from storms, except for a very short period.

Q. What is the weight of a cubic foot of water at 70 degrees?

A. The weight at 70 degrees according to a table published in the American Civil Engineers Pocketbook, Mansfield Merriman, Editor in Chief, is 62.3 pounds per cubic feet.

Q. What is the weight of a cubic foot of water at 33 degrees?

A. About 62.418.

Q. During these tests that were made, were the pumps at 39th Street and along the North Branch stopped?

A. Yes.
Q. They were not running?
A. No.
Q. For how long a period?
A. We stopped them, I think it was the night before the test started; that is my recollection. That is the fresh water pumps. Of course we had to keep our sewage pumps going.
Q. How much difference in the flow through this south branch and the north branch would be occasioned by the stoppage of the pumps?
A. The pumps at Wilmette pump a thousand cubic feet a second; the ones at Lawrence Avenue, pumping through the Lawrence Avenue conduit, 40,000 cubic feet a minute, which is about 700 cubic feet a second, and the fresh water pumps at 39th Street, about 1700 cubic feet a second, the way we were running them at that time.
Q. About 7200?
A. 1700 cubic feet a second, the way we were running them at that time.
Q. Instead of 2,000?
A. At that time, we had just been running part of the plant.
Q. And those along the north shore were running how much at that time, during the test?
A. They were not running any.
Q. Any pumps at Fullerton Avenue?
A. There is a pump there, yes.
Q. Was that run ordinarily?
A. They run that ordinarily, yes.
Q. It was not running then?
A. I gave orders that it should not be running.
Q. So that the decrease from pumping plants was about 3400 cubic feet a second?
A. In round numbers, I would say that was so, 3,000 to 3400 somewhere in there.
Q. Wasn't there a great deal of storage in the south branch and the north branch of the river that would affect conditions at Dearborn Street, have to be drawn off?
A. Any lowering that was produced at the forks or the junction of the north and south branch would draw down the storage. For that reason I shut down these pumps so as not to have an excessive amount of it. There would have been more storage to have been drawn off, if those pumps had been working.
Q. In those computations that you made from 5:30 to

12:30, if you leave out Lemont, you very nearly check with the Power House, do you not?

A. I have not tried it.

Q. Have you got the figures before you?

A. If you leave out Lemont, it would give an average of 10,300 cubic feet per second as I figure it.

Q. And in this case as in the others, Lemont is quite a little higher than the other five measurements and is higher than the determinations at the Power House, is that not true?

A. It is higher. I would not say it is quite a little higher; I would say some higher.

Q. You made a change in the amount of flow between 5:30 and 6:30, did you not?

A. We changed the method of the discharge through the end of the canal.

Q. And increased the amount of flow?

A. I presume it increased the flow, but that was not intentional. We were trying to get as near that steady flow as was possible, but as I stated before I am of the opinion that those wheels under-rate the amount of water that is going through them, particularly when they are working under a full load, heavy load, with a low head.

Q. The chart shows about 400 change, does it not?

A. That is taken from the record.

Q. I mean at the Power House and Controlling Works?

A. Yes, sir, taken from the record of these wheels acting as meters.

Q. If the wheels under registered, that change would be even greater, would it not?

A. If they gave too small a rating, then the change would be greater.

Q. So that you were getting a change along about the 5:30 and the 6:30 hours, too?

A. There might have been some change there, but it was not as great a change or anywhere near it as from 4,000 to 10,000 cubic feet, the change that we put on at twelve o'clock noon.

Q. Did you understand that in the last average we made in regard to Willow Springs we left out the one o'clock hour?

A. I know you were talking a great deal about it. I do not remember now whether that was left out in all of the computations or not. I think at first you had it in and then you said you were willing to leave it out.

Q. The average was made with it in and with it out, was it not?

A. That is my recollection. As I said, you were talking so much about it, I have forgotten.

Q. And the average including that computation at one o'clock is greater than when it was left out?

A. I do not know. The record will show.

Q. The record will show that? It is consistent with all of these computations, both from one o'clock to five and from 5:30 to 12:30 as made, even with the assumption that the water at the Power House from 12 to 5, was overestimated, is it not; it is consistent with the other results?

A. As I stated before, I think we come nearer getting the accurate measurement of the water at the Power House when most of it is going over the dams, or the larger percentage of it is, than we do when most all of it is being used through the turbines.

Q. You think then that the error at the Power House and Controlling Works is more likely to come after six o'clock than before?

A. Well, under the conditions such as existed at that day.

Q. At that day?

A. Yes.

Mr. Adcock: Q. These computations that you have made in response to questions from the Cross-Examiner, and in response to questions on re-direct do not show any material disprecancy at the Power House?

A. I think the results under the circumstances are remarkably good.

Mr. Hopkins: Q. You mean within 10 per cent. one way or the other?

A. I did not say that.

Q. What do you say as to that?

A. What I said in a former examination was—

Q. What do you say now as to that?

A. I have not said anything.

Q. What will you say as to that?

A. I do not know how close this is to the absolute truth. All I know is that we had as competent men as it was possible for me to get to make these measurements, using the most up-to-date instruments and methods and I have given you the results as shown by the experiments made and by the computations that were honestly and competently made.

Q. But you prefer to take one of those rather than five,

even when you state you think that the measurement at the Power House may be ten per cent. in error,—you use the others to check on that?

A. I did not say that, if you will pardon me.

Q. I so understood you?

A. No. What I said was that the amount of water going through the turbines might be 10 per cent. in error. If I did not say that, I meant to say that, in my opinion. That was sometime ago and I put that on as the outside limits.

Q. Have you had occasion to change that?

A. I do not know whether the error is that much or not. I imagine it might be under a heavy load and low head, particularly.

Mr. Hopkins: That is all.

Thursday, May 21, 1914, 2:00 o'clock P. M.

GARDNER S. WILLIAMS, a witness recalled in sur-rebuttal on behalf of the defendant, having been previously sworn, testified as follows:

Direct Examination by Mr. Adcock.

Q. Mr. Shenehon in his cross-examination as to ice effects on the St. Clair River stated that Lake Erie normally rises about $2\frac{5}{8}$ inches during the month of February of each year. Have you examined any data to determine the correctness of that statement since the examination of Mr. Shenehon? If you have, will you state what examination you have made and what your results are?

A. Table 26 of the Report of the International Waterways Commission on the Regulation of Lake Erie, 1910, in column 5 shows a change in elevation of Lake Erie for each month from February, 1860, to December, 1907, inclusive. And I find upon averaging the changes for the month of February for the 48 years that the average change is a rise of 0.054 feet, which is equal to 0.67 inch. I find that out of the 48 years considered, Lake Erie lowered in 19 of them.

Q. That is for the month of February?

A. For the month of February. And if these be excluded, the average change for the remaining 29 would be a rise of 0.18 feet, equal to 2.18 inches; so the figures of $2\frac{5}{8}$ inches appears to be in error under either consideration.

Mr. Hopkins: What period of time did he take, do you know?

Mr. Adcock: Q. He stated that as a general proposition, did he not?

A. Mr. Shenehon arrived at this figure from a somewhat hasty examination by the hydrograph of the Great Lakes; and I do not assume that he made any computation to establish that relation accurately.

Q. What do the changes in elevations of Lakes Erie, Michigan and Huron for February, 1901, indicate to you as to the accuracy of the conclusions regarding ice effect given by Mr. Sabin in the report of the Chief of Engineers for 1902 (printed record, page 2496).

A. For the month of February, 1901, the surface of Lake Erie fell 0.24 feet. Assuming that for average conditions it should have risen 0.054 feet, the total change from normal would be a lowering of 0.294 feet, which would reduce the discharge of the Niagara River, using the Complainant's value of the increment about 3200 cubic feet per second nearly.

Subtracting this from the reduced discharge for February of 85,900 cubic feet per second as given by Mr. Sabin leaves 82,700 cubic feet per second to produce a lowering in Lake Erie. The abstraction from Lake Erie of 82,700 cubic feet per second for 28 days would lower that lake 0.78 feet, therefore during the month of February, 1901, Lake Erie should have fallen 0.78 feet from its normal, whereas it did fall only 0.294 feet or the effect on Lake Erie was only about 38 per cent. of what Mr. Sabin's figure would indicate.

Considering the effect on Lakes Michigan-Huron of reducing the flow of the St. Clair River 85,900 cubic feet per second for 28 days, as testified to by Mr. Shenehon, this would raise Lakes Michigan-Huron 0.18 feet. Lakes Michigan-Huron did actually raise during this month 0.06 feet, which corresponds exactly with the average change of those lakes for the month of February for the 48 year period from 1860 to 1907, as shown by Table 25 of the Report of the International Waterways Commission, already cited.

In view of these facts, it is my conclusion that the estimated effect of ice in the St. Clair River for February, 1901, is about 150 per cent. too large.

Q. What estimated effect?

A. The reduction of discharge of 85,900 cubic feet per second.

Q. That is as given by Mr. Sabin?

A. As given by Mr. Sabin. Reducing the amount as given by Mr. Sabin 85,900 cubic feet per second to correspond to these indications gives about 33,000 cubic feet per second

which checks almost exactly with Mr. Russell's figure of 34,070 in the report of the Chief of Engineers for 1904 (printed record, page 2518), which latter value was deduced from a comparison of the discharge of the St. Clair and Detroit Rivers.

Q. You were asked on your cross-examination, when you previously testified in this case (printed record, page 979), as to the consideration given to ice effects. Will you state the result of your investigations as to ice effect upon the discharge of these different outlets of the lakes under consideration in this case?

A. Ice effects as referred to in this case should include cold water effects, and may be classified under three heads, which in the order of their importance are:

First: Effect of cold in reducing the fluidity of the water.

Second: Effect of ice cover in cutting off cross section and reducing velocity in upper part of the stream.

Third: Effect of ice jams in temporarily retarding the flow.

As to the first: The effect of low temperatures on the flow of water has long been studied. In the flow through filter sands, the discharge of water at temperatures between 32 and 45 degrees fahrenheit is only about 60 to 70 per cent. of that of water at 70 degrees. The influence of this factor was encountered by me in some tests of turbine wheels at Holyoke about 15 years ago when the efficiency of the wheels was reduced between two and three per cent. on account of the effect of cold upon the fluidity of the water. Its effect on the flow in pipes and over weirs has been studied, and experiments upon the Sanitary Canal show the discharge to be reduced about ten per cent. between summer and winter conditions, which latter include floating ice.

As to the second: The formation of ice on the surface of a stream cuts off the cross section to the extent of about 9/10 of the thickness of the ice, and in addition the flow in the upper portion of the stream is retarded so that the vertical curve of velocities takes the form shown on Turner's Exhibit 1 (record printed, page 1569) rather than those on Shenehon's Exhibit C, for Identification (Record, printed page 2479). The combined effect of the two influences of ice cover has been variously estimated at from two to ten per cent.

As to the third: Ice jams are of intermittent occurrence and limited duration. While during their existence they notably reduce the discharge, this is compensated for in a large measure by the corresponding increased flow when they give

way, due to the increased slope coming from the storing of the water in the upper lake and the lowering of the level of the lower one.

Q. Is there a marked increase of slope at that time?

A. Quite decided, depending upon the permanence of the ice jam; the longer it lasts, the more it backs the water up above it and lowers the water below it and when it gives way, you have a high inclination relatively and markedly increased flow for some time, until the conditions adjust themselves.

Q. The flow is very much accelerated on account of that condition, immediately following the breaking up of the jam?

A. Yes. It is always accelerated to an appreciable amount.

If a jam should be assumed to block the St. Clair River completely for ten days so that no water flowed, it would reduce the annual discharge less than 2¾ per cent., omitting the compensation due to increased flow after it gave way; and if this were considered the effect of the jam would be even less than indicated by the percentage given.

No such stoppage has ever occurred, and it is to be doubted—I will say has ever occurred so far as any records or the memory of man indicate—and it is to be doubted if one reducing the flow 50 per cent. has existed.

The duration of ice jams rarely exceeds a week, so that the influence of this factor is of far less consequence than either of the others.

As to the distribution of these effects, the first, temperature influence is present with practically equal force in all the outlets of the lakes including the Sanitary Canal.

Similarly, the second, ice cover is a factor on all the rivers and on the canal, though of slightly greater importance on the canal, the St. Clair and Detroit Rivers and the St. Lawrence than on the Niagara.

The third, ice jams occur in all the outlets and on the canal, though those at Niagara usually occur later in the season than the others.

It is therefore my conclusion that any effect of cold and ice on the lake outlets will similarly influence the flow in the canal and so far as changing the estimated lowerings due to the actual Chicago diversion, is of no consequence, and that any difference in proportionate effect on the Niagara and the other rivers is far too small to account for the long known discrepancies between the measured Niagara discharges and those of the other lakes, that have puzzled engineers for more than a quarter of a century, and are still unexplained.

Q. Certain comments have been made by witnesses for

the Complainant, intended I believe in the nature of criticisms of the accuracy of weir measurements at the Cornell Hydraulic Laboratory in connection with the current meter tests of Professor Schoder, as described in his testimony (record printed page 1548). What can you say as to the accuracy of the weir measurements there?

A. The two weirs at Cornell were originally constructed under my direction, during the time I was in charge of the laboratory. The lower one as then built was a duplicate of the weir used by Messrs. Fteley and Stearns in their Farm Pond Experiments, except that it was 6.65 feet high instead of 6.55 feet, and it was 16 feet long instead of 19 feet. The effect of this small change in height, as testified by Mr. Haskell (record, printed page 2689) with which I fully concur, would make practically no difference, or would make no difference that could be detected by the most careful measurements of discharge that it has yet been possible to make upon the volumes of water concerned; and the discharge per foot of length of this weir at Cornell would be the same as that of the weir in the Farm Pond Gate House, the discharge over which was measured volumetrically by Messrs. Fteley and Stearns.

The formula derived by those investigators for the flow over their weir agreed within less than .2 of 1 per cent. of the measured discharges over it, and it is therefore my belief that their formula is applicable to the discharge of the Cornell weir within .3 of 1 per cent. Mr. Haskell estimated within .2 of 1 per cent. (record, printed page 2689).

Comparisons of the flow over this weir and the weir at the head of the canal, which was 11.25 feet in height, were made by me during three years, and the discharges as computed from the weir formulae in a series of over 100 simultaneous measurements agreed within 1 per cent., and for heads near that used by Professor Schoder in his current meter tests agreed within less than 1/2 of 1 per cent.

Since that time, Professor Schoder has changed the elevation of these weirs each about a foot, and has made a volumetric calibration of a section of the lower weir 4.22 feet long, in which the measured discharges for the same heads, which were repeated several times, agreed within considerably less than .1 of 1 per cent., and from the results of these final tests the weir discharge used for comparison with the current meter tests was computed.

It is therefore my conclusion, and my best judgment, that the weir discharges used by Professor Schoder were cer-

tainly accurate within less than 1 per cent. Mr. Haskell testified to an accuracy under the conditions before stated within considerably less than 1 per cent. (Record, printed page 2700.)

Q. Mr. Schoder testified as to certain current meter tests made in the laboratory at Cornell University. Have you any opinion as to the applicability of those tests to the conditions on the Niagara River, International Bridge Section?

A. During my connection with the hydraulic laboratory at Cornell University which I was in charge of for a period of six years, I observed on many occasions conditions similar to those which existed during the tests made by Professor Schoder. And from my recollections of those conditions, which I may say involved not only an observation of the surface of the water but measurements of the discharge with floats and current meters, observation of floating matter in the water, such as water logged sawdust, leaves and other foreign substances that would float at various depths below the surface, and from my observation of the condition of the surface of the water passing underneath the International Bridge, and my observations of the conditions in flowing water set up by similar obstructions in streams and elsewhere, it is my opinion that the conditions of experiment number 8 (record, printed page 1548) by Mr. Schoder were reasonably correspondent to the conditions in the mid channel between the piers of the International Bridge. And that the conditions of experiment number 9, would be quite applicable to the conditions in the region near the piers of the International Bridge.

Considering further the statement of Professor Turner that during the tests in the canal the meter was vibrating sidewise and up and down (record, printed page 1586) and the evidence of the record of direction current meter observations at Niagara shown on Shenehon's Exhibits C and D, of May 16, I also consider the conditions quite similar and that the errors of registration indicated by Professor Schoder's tests are applicable to the conditions at the International Bridge.

Mr. Adcock: I show the witness three sheets entitled "Direction measurements of Vertical Curves International Bridge, Plotted from Shenehon's Cross-Examination Exhibit C," the three sheets being similarly entitled, and ask that they be marked Williams' Exhibit 36.

(Three blue prints shown to witness were marked Williams' Exhibit 36.)

Q. I will ask you to describe the exhibits and state from what data they were prepared, and what they show?

A. Exhibit 36 was plotted from Shenehon's Exhibit C of May 18th, I believe, and represents graphically the directions there indicated as they were taken by the current meter at stations in the fourth span of the International Bridge.

Q. Was that the middle of the river?

A. That span is the one which carries the largest proportion of the discharge of the Niagara River.

Q. And was the span referred to by Mr. Shenehon in his cross-examination as such?

A. It has been referred to as one of two spans which carry over 50 per cent. of the discharge; and on page 5328 of the report of the Chief of Engineers for 1900, the percentage of discharge passing this span is given as 28.2.

I should say that the data in Shenehon's Exhibit D, is also included in these plottings.

The vertical line headed "Station 4 2/12" on each plate represents a direction at right angles to the International Bridge, and at right angles to the section that was measured.

The 4 2/12 locates the position of the meter in the cross-section horizontally as being 2/12 of the span from the pier. Similarly, the heading of the middle vertical, "Station 4 6/12" locates the meter as at the mid point or on a middle vertical of span 4. And the heading of the third vertical "Station 4 10/12" locates it as being at 10/12 the span from the American side, or 2/12 of the span from the pier at the Canadian end of span 4.

The first groups of radiating lines on the respective verticals indicates the positions taken by the meter at the water surface, that is when just a little more than immersed.

It will be noted that on the vertical near the pier at the left, the meter rotates in its position through more than 90 degrees.

The second series of rotating lines represents the position of the meter at the 1/10 depth, which is indicated by the numerals 0.1 underneath this group.

Similarly, the next group represents the various positions of the meter with the directions in which it was pointing at the .2 depth; similarly as to the .3, .4, .5, .6, .7, .8, .9, and at the bottom.

It is to be noticed that the variations of direction are substantially the same in magnitude whether the meter be at the 2/12 or the mid station point. The variations in direction are somewhat less in the upper part of the section at the

10/12 point, but in the lower part the changes are quite as marked as they are at the other positions.

These plottings represent graphically the changes of direction as recorded by the meter and indicate the disturbances of the flow through this section.

As regards the lower portion of the 4 10/12 vertical, the large variations there are probably due to the fact that the meter was no longer between the bridge piers, but had drifted downstream a considerable distance beyond the foot of the pier.

Q. So that the vertical line that appears on each sheet of the exhibit is a line which is at right angles to the gaging section line. Is that correct?

A. Yes.

Q. Then if the tail of the meter were on a line at right angles to the gaging section line, the line drawn through the tail of the meter and the station would coincide with the vertical line which appears on those sheets. Is that correct?

A. Yes, that is correct.

Q. The lines at an angle from the vertical line represent the position of the meter with reference to the line normal to the cross section. Is that right?

A. The line perpendicular to the cross section.

Q. Or perpendicular to the cross section?

A. Yes, those radiating lines represent the successive positions of the meter that were observed, and indicate to my mind the turbulence of the water, as there seems to be no continuity, no steady direction of the current, but it seems to be changing continuously.

Q. In other words, if the water were not turbulent, the meter would stay in one position, even if the current were not exactly normal or perpendicular to the discharge section?

A. It should stay very nearly in a constant direction. Of course a small vibration is to be expected, but no such vibration as observed here.

Q. Where you have a variation in position of nearly 95 to 100 degrees?

A. In several cases.

Q. Haskell's Exhibit A, of February 25, 1904, has been referred to by Mr. Haskell and also by Mr. Shenehon in the cross-examination of each of them. Will you describe Haskell's Exhibit A of that date?

A. Haskell's Exhibit A comprises six columns of figures.

The first column represents the elevations of Lake Huron at Harbor Beach during the open seasons of each year from 1884 to 1908 inclusive, referred to a datum 335.5 feet above sea level.

Column III represents the elevation of Lake Huron at Harbor Beach referred to the same datum for the mean elevation in the groups of observations shown on Williams Exhibit 21, being the groups shown on Complainant's Exhibit 1, including the observations of 1901 and 1908.

Column V represents the same elevations as Column III, excluding the observations of 1901.

Column II shows the mean fall between Lakes Huron and St. Clair during the open season for the years whose Huron elevations appear in column I.

Columns IV and VI show the falls from Lake Huron to Lake St. Clair for the groups of observations whose Huron elevations appear in Columns III and V respectively.

Q. The witnesses referred to made certain comparisons of the conditions shown by those various groups, expressing a preference for columns III and IV in relation to the conditions of I and II. Will you state what those conclusions have to do with the investigation with reference to the increment of the St. Clair River?

A. The preferences expressed by Mr. Haskell and Mr. Shenehon for the data in columns III and IV, over that in columns V and VI to be used in deriving a discharge curve to apply to the conditions of columns I and II—

Q. When you say a discharge curve, you mean a discharge referred to the elevation?

A. Yes. A discharge referred to the elevation,—confirms the correctness of the contention in my direct testimony that the observations of 1901 on the St. Clair River should have been included without correction in deriving the increment on Complainant's Exhibit 1, and that the increment there shown for the St. Clair River should have been about 28,000 as shown on Table XV of Williams' Exhibit 34, instead of 23,820 as given on Complainant's Exhibit 1, and as testified by the Complainant's witnesses in their 1909 testimony.

Q. As I understand, it has been stated by various witnesses for the Complainant that the method of getting the discharge of the river is, first, to observe the velocity at various depths on a series of verticals for a number of cases, and to find a ratio between the mean velocity of these verticals and the velocity at some point called the index, so that by observing the index velocity the mean velocity can be com-

puted without occupying with the meter the several stations on the several verticals. Am I correct?

A. Yes, that is correct.

Q. And that the ratio of velocity at any particular point or for any particular vertical to the index velocity is based on the mean of several velocities observed at the point or throughout the vertical. That is also true, is it?

A. Yes, that is the manner of determining the ratio between the individual points or the mean velocity in the vertical and the index.

Q. Is the method described a reasonable process for obtaining an average discharge?

A. Yes, so far as getting an average discharge is concerned, it is practically correct or reasonably correct.

Q. Is it a reasonable process in getting an increment?

A. No, it is not.

Q. What reasons have you for reaching that conclusion?

A. The correctness of the process, or the alleged correctness of the process depends upon the assumption that a constant ratio exists between the velocity at the index point and that at any other point in the section at the same time. This is only approximately true since the form of the vertical velocity curve changes with the depth.

Referring to page 2479 of printed record entitled "Typical Vertical Curves," it is seen that in the case presented for a depth of about 35 feet, the retarding effect of the bottom becomes pretty well eliminated by the time mid-depth is reached. In deeper sections the portion of the curve at the top which is nearly vertical extends over a larger proportion of the depth while in shallow streams the drag of the bottom extends nearly the full distance to the surface.

It therefore follows that the ratio by which the index velocity should be multiplied to give the mean will be less in a shallow than in a deep stream, so that the process of taking an average value for this ratio derived from verticals taken at different stages results in the high discharges being reduced and the low ones increased; as the high discharges correspond to high stages and vice versa, the difference between high and low discharges is reduced and the increment correspondingly reduced.

With discharges of 220,000 and 200,000 cubic feet per second, an error of ½ of 1 per cent. due to using a mean index ratio will make a reduction of over five per cent. in the difference and a similar percentage error in the increment.

These ratios also vary with wind and barometic changes.

Q. You have spoken of the difference between high and low discharges as being reduced, and then you say that from that you reach a conclusion that the increment is correspondingly reduced. I wondered if you could explain that so that we may understand it just a little bit better.

A. Assume that at a certain elevation the current meter gaging shows a discharge of 220,000 cubic feet per second; that the ratio of the index to the mean velocity that is used was .80, and that this was in error ¼ of 1 per cent. for this discharge, being small by that amount. Then the coefficient used should have been .802. And if .802 had been used, the discharge would have been ¼ of 1 per cent. greater or 550 cubic feet per second. The real discharge would then have been 220,550.

Assume at the lower discharge the current meter gaging gives 200,000 cubic feet per second, and in this case the coefficient should have been .798 instead of .802, when the true discharge would be ¼ of 1 per cent. less or 500 cubic feet per second less, which would make the true discharge 199,500. The difference then was 21,050 cubic feet per second, whereas the difference of the original discharges was 20,000. The corrected value then is a little over five per cent. greater than the reported value. Now this is an error that so far as the increment is concerned is always in one direction.

Q. That is making the increment too small?

A. It always makes the increment too small. It is not a compensating error in any sense of the word.

Q. Am I correct in this understanding that the determination of an increment is essentially the correct determination of the discharges between a higher and lower elevation?

A. That is necessary for the determination of an increment.

Q. Then given a number of discharge measurements, and assume that the discharge measurements are referred correctly to the elevation of the lake, you may take the discharge at the highest elevation and the discharge at the lowest elevation, take the difference; and then take the discharge at the next pair all the way down, and the mean of those would be the true increment?

A. If the discharge were correctly measured.

Q. If the discharges were referred correctly to the elevation?

A. And were correctly measured.

Q. And were correctly measured? So that if the discharges at the high elevation were in each instance, taking a

number of discharge measurements, too low, and the low elevations were too high, the result would be that the increment would be too low?

A. The difference would be too small.

Q. And the increment would be too small?

A. And the increment would be too small also.

Q. Mr. Witness, I show you a photograph of a document headed "Lake Levels Niagara River, Vertical Curves Span 6, Station 4/12 International Bridge Section F. C. Shenehon Asst. Eng." This document, as I understand it, is attached to a letter written by F. C. Shenehon to E. E. Haskell dated February 13, 1899, and was furnished the defendant on request by Colonel J. C. Sanford, now in charge of the United States Lake Survey. I will ask you to describe the document handed you and state what in your opinion it has to do with the conclusions which you have reached in connection with the subject matter of the last question, and with matters under examination in this case.

I further ask that the document be marked Williams' Exhibit 37.

(Photograph of document referred to was marked Williams' Exhibit 37, May 21, 1914.)

Mr. Hopkins: That includes the letter?

Mr. Adcock: I will put the letter in if you want it.

Mr. Hopkins: Is that document you are offering a part of the public records there?

Mr. Adcock: Yes.

Mr. Hopkins: In connection with this work, or simply a letter between Mr. Shenehon and Mr. Haskell?

Mr. Adcock: As I understand, the letter discussed various subjects in connection with the measurement made by Mr. Shenehon at the International Bridge Section of the Niagara River. I will say this: If the United States wishes to offer the letter also, they may do so without objection to us; but for the purposes of this examination, the exhibit mentioned is all we desire; and we believe it unnecessary to encumber the record with the letter itself.

Mr. Hopkins: I would like to reserve an objection. I simply do not want to be understood as admitting that any letters written between people who happen to be in the employ of the United States Government are by virtue of that fact admissible.

Mr. Adcock: I assume that this letter was written by Mr. Shenehon in connection with his duties as assistant engineer in the Lake Survey Office, and the principal assistant engineer

in immediate charge of the Lake Survey in the measurements of the Niagara River at the International Bridge.

Mr. Hopkins: I know nothing about that. Without anything here to show what it is, I simply reserve an objection to it.

Mr. Adcock: I believe the request was made to the United States Attorney in charge of this case. And I assume that at some time you have been advised of the contents, although you may not exactly remember what it was.

Mr. Hopkins: We have always consented to have you furnished with a copy of anything that related to these issues, so far as that is concerned, but did not intend thereby to admit it was competent or admissible in evidence.

Mr. Adcock: You admit that this is a copy of—

Mr. Hopkins: Subject to verification, we will not dispute the authenticity of that letter.

Mr. Adcock: As to the materiality and relevancy and perhaps the competency, outside of the question as to being an accurate copy, you reserve the objection.

Mr. Hopkins: Yes.

A. This is a photograph of a document on file in the records of the Lake Survey at Detroit and is in part, or purports to be in part the record of current meter observations for the vertical curve at Station 4/12 of span 6, of the International Bridge.

The observations as indicated by the first column were taken on February 4 and 6, 1899. The column headed B gives the vertical depth of the meter in feet from the surface; and these positions are 1 foot, 3 feet, 6 feet, 9 feet, 12 feet, 15 feet, 18 feet, 21 and 24 feet respectively.

The column headed C, gives the length of the run in minutes.

Column D, gives the velocity by the index meter at the 3/10 depth.

Column E, gives the velocity by the traveling meter at the various depths indicated in Column B.

Column F, gives the per cent. velocity on the vertical to the velocity at the discharge station. That is it is the reading of the traveling meter divided by the reading of the meter at the 3/10 depth point.

Column G, gives the weights of the several observations, which are weighted according to time.

Column H, gives the weighted mean of the ratios for each point between the traveling meter and the meter at the index point. The average value of the weighted means is 84.4 per

cent. If we take the average value of the maximum ratios for each point as indicated in column F, this would be 85.94 per cent. If you take the average value of the minimum ratios for each point, we would get 80.95 per cent. showing a range of 5 per cent. in the averages of these ratios between those representing the maximum condition and those representing the minimum.

If we take the mean of the first observations at each point, we get 84.3 per cent. which practically coincides with the weighted mean, and if we take the mean of the fourth observation at each point, we get 85.1 per cent., showing a variation in this instance of .8 of 1 per cent. in the average for the entire vertical depending upon whether we take the first observations that were taken or the fourth.

There is no information available on the sheet to tell the elevations of lake surface corresponding to these observations, so that the effect of using the mean ratios instead of the actually observed ones, upon the derivation of an increment cannot be worked out from the data on this sheet, yet it indicates quite clearly the range through which these ratios between individual points and the index may pass.

In the report of the Chief of Engineers for 1900, page 5374, Mr. Sabin gives the results of his observations on the St. Clair River divided according to stage, although the stages are not given except that one set includes a certain elevation and those above it and the other set includes those below that elevation. The mean ratio for the upper stage of the observations between the 1/10 and 8/10 depth points inclusive is 96.79 per cent., and that for the lower stage is 96.58 per cent. The variation from the mean is 1/10 of 1 per cent. The range of stage, as I said, is not given.

Q. Mr. Williams I show you a plotting, which apparently represents certain vertical curves entitled "Niagara River Section Oakfield Vertical 8." I will ask that it be marked Williams' Exhibit 38, and ask you to describe the exhibit and state your conclusions from that exhibit with reference to the subject matter now under discussion.

(Plotting described was marked Williams' Exhibit 38, May 21, 1914.)

A. This is a plotting from the records of discharge observations at Section Oakfield on the Niagara River, which records were furnished by the office of the U. S. Lake Survey.

Q. That was a part of the Split Section?

A. Part of the Split Section. The numbers at the top of the plate represent the percentage which the velocities at the

several points are of the index velocity which is that at the 4/10 depth. The numbers at the right hand show the proportionate depths from surface to bottom. The broken lines connect the consecutive observations or observations made of the vertical at practically the same time.

The general form of this discharge curve, the mean of this curve will be found to bear out my statement made a short time ago that in the shallower water the effect of the bottom extended more nearly to the surface.

The depth at this station was, as I remember it, a little over 20 feet.

It will be noticed that the variations of velocity at the individual points represented on the horizontal lines cover a range between 8 and 10 per cent. of the index velocity. This plate therefore gives a graphic idea of the irregularity of velocities at the same points or depths in a vertical curve; and also indicates by the irregularity of the observations at the bottom, which cover a range of something over 20 per cent. of the index velocity, the disturbances set up in flowing water in the vicinity of the bounding surface. My own observations of the flow of water in pipes and open channels indicate that similar disturbances occur along the side walls of the latter and around the circumference of closed pipes; and that such disturbances are to be expected in the vicinity of the piers at the International Bridge.

Any one of the curves shown on Williams' Exhibit 38, might be the one corresponding to the condition at the time of a particular gaging, and by using an average value for the index ratio, an error of anywhere from 2 to 4 per cent. may be introduced. As the same causes which produce low readings in one vertical will produce them in the others, there is little or no compensation by balancing errors, and the whole discharge is similarly in error. In the case of the ratios being low for a lowering of the stage, then our average value for the ratio gives a discharge for the low stage which is greater than that actually existing and vice versa; so that the increment resulting from the observations is decreased.

Similarly in the case of increased ratios by a rising of the stage the use of the average ratio reduces the discharge at the high elevations and again decreases the increment as I have already stated.

Q. I show you Mr. Williams two charts which were marked Shenehon's Exhibits A and B for Identification, cross-examination. These charts were shown Mr. Shenehon on the occasion of his cross-examination in this case. I ask

that they be marked Williams' Exhibit 39A and 39B, and ask you to describe the charts and state by whom they were prepared and from what data.

(Charts shown to witness were marked Williams' Exhibits 39A and 39B, May 21, 1914, respectively.)

A. These are two charts which are plotted from the information contained in Williams Exhibit 4, for Identification, cross-examination, being the gage elevations at Buffalo and Chippewa for the month of November, 1908, showing the hourly water levels. The upper curve represents to the scale indicated by the elevations at the left of the sheets the elevation of the Buffalo gage from hour to hour, the dates and hours being indicated by the letters and numbers at the bottom of the sheets.

The lower irregular line represents the elevations indicated by the gage at Chippewa for the same dates and hours.

The charts indicate the regularity or irregularity with which changes at Chippewa follow changes of the Buffalo gage, and show graphically the extent to which the fluctuations of the Buffalo gage disappear in traveling down the Niagara River.

Adjourned to Friday, May 22, 1914, 2:00 o'clock P. M.

Friday, May 22, 1914, 2:00 o'clock P. M.

GARDNER S. WILLIAMS resumed the stand for further direct examination by Mr. Adcock and testified as follows:

Q. When a meter is used in swift running water and suspended upon a cable, what effect does the current have on the position of the meter?

A. It drifts the meter down-stream.

Q. What effect would the drifting of the meter have upon the discharge measurements usually?

A. In ordinary cases, it would have very little effect. In fact, if the section were uniform in area and shape throughout the length of the drift and a proper allowance were made for the change in vertical position of the meter due to the fact that more cable would have to be paid out in order to have it at the same depth, there should be no effect of consequence introduced into the discharge measurements.

Q. At the International Bridge Section of the Niagara

River, what would be the effect of drift? Is it an important proposition there?

A. It is, quite, for the reason that the piers which carry the bridge terminate a short distance below the section, and if the drift should be such as to carry the meter below the lower end of the piers, the meter would then be in a considerably larger section than that which has been measured, and the velocities there would be appreciably less; so that if the meter were in that position and the velocity measured, and those velocities applied to the area of the section between the piers, which is the one which was measured with the high degree of accuracy testified to by the Complainant's witnesses, the result would be a considerable diminution in the discharge.

Q. How far could a meter drift at this section from the plane of the station before it was below the piers of spans 4 and 5 of the International Bridge, those spans being the spans through which I believe about 50 per cent.—

A. A little more than 50 per cent.

Q. —a little more than 50 per cent. of the water of the Niagara River flows at the Bridge, as testified to by Mr. Shenehon.

A. A drift of between seven and eleven feet depending upon the depth at which the drift took place would carry the meter beyond the lower end of the pier, according to the best information that I have been able to secure.

Q. You have heard the testimony of the witnesses and examined the reports of the Chief of Engineers to determine what precautions were taken by the observers to prevent drifts. Will you state what those precautions were?

A. Yes, I have heard the testimony and have examined the printed records so far as they are known to me bearing upon this point; and the observers attached by means of a snatch block and a weight a guy to the cable of the meter so that the snatch block rode at any point—so that the weight, rather, rode just above the water surface. This guy was carried to the up-stream edge of the bridge around the outside of the *I* bars, and by pulling up on this guy the position of the cable could be shifted within certain limits at the water surface.

Q. How was the amount of pull or the distance that the meter cable was moved established?

A. The distance through which the cable should be moved was established by a series of computations based upon certain assumptions as to the effect of current on the cable and on the meter.

In the paper of Mr. Clinton B. Stewart, who had charge of

the discharge measurements at Niagara made for the Board of Engineers on Deep Waterways, which paper has been referred to in evidence in this case previously, and which was presented to the Western Society of Engineers and was read December 20th, 1899, and which is a description of the work done at the Niagara River for the International Waterways Commission, being practically the substance, in fact most of it word for word, a reprint of the report of the Board of Engineers on Deep Waterways upon this subject, there appears a plate entitled "Figure 6," which is not published in the report of the Board, but which was made in connection with the studies of the position of the meter in this gaging. And it is this study which is referred to on page 5332 of the Report of the Chief of Engineers for the United States Army, 1900, being the report of Mr. F. C. Shenehon, on the discharge of the Niagara River.

"The analysis of meter positions was first made by Mr. C. B. Stewart in discussing the Deep Waterways observations on this river, and out of this germ has been developed our own tables for meter location, and the static method of sounding."

Mr. Adcock: I ask that the plate referred to in Mr. Stewart's paper read on the 20th of December 1899 before the Western Society of Engineers be marked Williams' Exhibit 40.

(Plate referred to by witness was marked Williams' Exhibit 40, May 22, 1914.)

Mr. Hopkins: Let me ask a question or two about that. (Q) Mr. Williams, does that chart appear in the report of the Engineers on Deep Waterways.

A. The chart does not.

Q. Does the detailed information appear in that report, so that any engineer could take it and make that chart?

A. I think that the mathematical analysis by which this chart was arrived at is not in the report. I would say that portions of this chart appear—

Q. Where is Mr. Stewart now?

A. Mr. Stewart is at the University of Wisconsin; he is a Professor there.

Mr. Hopkins: I wish to reserve an objection to the competency of that chart. I do not object on the ground that it is not the exact chart as appeared in the report to the Western Society of Engineers, but I do reserve the objection that merely because it is there, it does not make it competent.

The Witness: I think it can be identified through Mr. Shenehon.

Mr. Adcock: Q. Who was Mr. Stewart?

A. Mr. Stewart was the engineer in charge of the discharge measurements in the field for the Board of Engineers on Deep Waterways.

Q. Was he a Government Officer?

A. He was employed by the Board of Engineers on Deep Waterways. I do not think that he had any other connection with the Government except his connection with the Board.

Q. The Board of Engineers on Deep Waterways was a Board appointed under an act of Congress, was it not?

A. It was, by President McKinley. This is the chart which he made while in the service, or it is a copy of the chart which he made while in the service of the Board of Engineers to apply to the analysis to determine the position of his meters when he was making the Niagara observations.

Q. The original chart which he made, was that made for the Board of Engineers on Deep Waterways?

A. It was, and I think is now in the possession of the Lake Survey.

Q. That is the original of this chart?

A. Yes, I think so.

Mr. Adcock: I understand no objection is made on the ground that it is not the best evidence; that it is a copy of the chart.

Mr. Hopkins: A copy rather than the original?

Mr. Adcock: Yes.

Mr. Hopkins: No, no objection on that ground.

Mr. Adcock: Q. Then your understanding is that it was simply preserved in this form in the transactions or reports of the Western Society of Engineers by a paper which he presented, the original of which was made for the Board of Engineers on Deep Waterways, while Mr. Stewart was in their employ?

A. That is my understanding.

And I will say further that my reason for producing it in this form here is simply that I had it in my possession. At the time I was last in the Lake Survey Office, I did not have in contemplation introducing this question into the evidence, and therefore could not foresee that a copy of it from that source would be needed. I saw however in Professor Shenehon's possession while he was on the stand what to all appearances without an exact comparison was a blue print from

the tracing from which this photographic reproduction was evidently made.

Mr. Hopkins: Q. What is the source of your information that it was made for that Board and in connection with his duties on that Board?

A. Because it was necessary that it should have been made or a similar chart should have been made in order to solve the problems which he had to solve. I was informed by the members of the Board at the time that such an investigation was being made, and in discussing the matter with Professor Shenehon this chart has been referred to between us.

Q. What I had in mind was perhaps this chart was made for this particular report of the Western Society of Engineers?

A. I feel quite sure it was not. Of course I have no personal knowledge.

Mr. Adcock: I want to say further that previously in this case both sides have used the transactions of the American Society of Civil Engineers and the reports of the Western Society of Civil Engineers which bore upon these hydraulic questions, without any objection as to their competency or the fact that the particular document was not accurately or carefully prepared from data in existence.

Q. Will you describe the exhibit, Williams' Exhibit 40?

A. This is an exhibit which represents graphically the computed position of the current meters or of a current meter in the Niagara River at various depths below the surface, the depths covered ranging from a point about a foot below the water surface to a point 1½ feet above the bottom of the river.

Q. That was in span what?

A. There is indicated here a depth of 52 feet, which would represent the deepest portion of the river, being in spans 4, 5 and 6.

This chart or plate indicates that in the deepest water the meter shaft or the point of suspension would be 34 feet downstream from the guard rail of the bridge with the guy wire attached carrying a weight of 121 pounds, which is however located and adjusted in a different manner from that used by Professor Shenehon as testified to a few days ago, and the effect of the weight as used by Mr. Shenehon would be appreciably greater than the effect of the weight as used by Mr. Stewart.

Q. "How was the amount of pull or the distance that the meter cable was moved established"?

A. (Quoting from Mr. Stewart's paper): The pressure of the current on the meter was determined by lowering the meter wheel one foot under water and measuring the vertical angle of the cable. Then the pressure on the meter equals that of the water multiplied by the tangent of the angle. The velocity was also observed and from a number of observations, a very good curve showing the relation of velocity and pressure on meter was observed. This is the curve shown in figure 6 that has been introduced.

The point that I make is that the position of the meter, the computations seem to determine the position of the meter as dependent upon the angle which the cable made with the vertical or with the horizontal—it would make no difference which—when running in water of a certain velocity, and that there does not appear to have been any direct measurements of the force required to hold the meter in position against the current.

Professor Shenehon, when he took charge of the work, as appears from a letter written to his Chief, Mr. E. E. Haskell, then Assistant Engineer of the United States Lake Survey, dated February 13, 1899, referred to in my examination yesterday, which letter is a part of the records of the U. S. Lake Survey and a copy of which I have—

Mr. Hopkins: Was this letter offered the other day?

Mr. Adcock: That was the letter referred to, yes.

Mr. Hopkins: Same objection to the letter and the reading from it.

(Witness continues answer as follows):

—recognized the fact that the drifting of the meter downstream to the extent of 30 feet might cause the lower velocities in the curve to show an error of ten per cent; and that there was some possibility of error being introduced by a doubt as to the position of the meter, on account of the great inclination of the cable. He therefore conceived the idea of using a heavier weight and a smaller cable, in anticipation that it would be possible to prevent the meter from drifting as far as it had formerly done. And he assumed that by reducing the ⅜ cable to quarter inch he would be able to reduce the pressures on the cable ⅓, and he obtained authority to make these changes, or at least these changes were made. He asks for the authority in the letter to which reference has been made, and introduced the smaller cable on Meter B, and a heavier weight on both Meters A and B, but retained the ⅜ inch cable on Meter A.

He then made a new computation to determine the position of the meter under the new conditions, and as a result of that computation arrived at the conclusion to which he testified, if my memory serves me right, that the drift of the meter in 50 feet of water with the small cable and the heavy weight would be 12½ feet. And upon the result of the computation which gave him that figure, he prepared a new chart of meter positions similar to the one which has just been introduced in evidence, and a blue print of which he had with him when on the stand; but as it was the only copy he had with him, I was not able to obtain a copy of it.

I made a cursory examination of it and found that the curve which he had adopted was similar in its general characteristics to that shown on the plate introduced, but had the base of 12½ feet instead of 32 feet as in the case of Mr. Stewart's curve. It was from this curve, according to Mr. Shenehon's testimony, that the locations of the meter were established, and corrections for its position made.

Q. Have you made or caused to be made any experiments to determine the accuracy of these assumptions?

A. Yes, I have.

Q. What experiments have you made and what are the results?

A. Upon the conclusion of Mr. Shenehon's cross-examination, I was impressed with the fact that the conclusions elicited in the cross-examination were not strictly in accordance with the laws of physics as I understood them, and I immediately arranged to have a series of experiments made in the naval tank of the University of Michigan, where we have been accustomed to rate meters and determine the forces which act upon a meter when it is subjected to a current; and also the forces which act upon the support.

For this purpose, Mr. Murray Blanchard from this office, who has had charge of the current meter work for the District on the sanitary canal, and who was formerly in the employ of the Lake Survey and participated in the measurements of the St. Clair and Detroit Rivers—

Q. He had charge of it?

A. He had charge of the measurements on the St. Clair during the last year, 1902, and had charge of the measurements on the Detroit River. He took the meters to Ann Arbor last Sunday or Sunday night. He was preceded by Mr. Ayres, my Assistant, who was here with me at that time, who made the necessary preliminary arrangements to get the use of the

tank without delay, and with the assistance of Professor Greene, formerly of the faculty of the University of Michigan, now of my office staff, and Mr. R. K. Holland, my Principal Assistant Engineer, a series of experiments were run to determine the force that was required to hold the meter when moving through the water at velocities ranging from 4 to 7 feet. These experiments were made with the apparatus which was used at the University for determining the force required to move boats and other structures through the water; the work being done under the immediate supervision of Professor Herbert C. Sadler, who was a witness in this case, and who has charge of the work in naval engineering at the University.

The resistance caused by the A Haskell Meter and the B Haskell Meter was measured, the meters being suspended upon a rod, and the resistence due to the rod was also measured, so that it could be deducted from the resistence of the meter and its weight, the weight being a reproduction of the weight described in the report of the Chief of Engineers for 1900, and illustrated in various illustrations relating to the work.

Q. Being the meter that was used by Mr. Shenehon, or the weight used by him?

A. The A meter, being the one used by Mr. Shenehon at the index point and the B meter, being the one used to traverse the vertical in coefficient work, as testified to by Mr. Shenehon.

Q. And the weight is the one—

A. And the weight being within about two pounds of the weight specified in the report.

Q. And the one used on the Niagara River?

A. And the one used on the Niagara, International Bridge, by the Lake Survey.

Q. Same shape?

A. Same shape as near as it was possible to establish it from the illustrations in the book.

The force required to resist the action of the water on the cables, quarter inch and three eighths inch was also observed, the cables being attached to the dynamometer with a weight at the bottom, and they were dragged through the water at the various rates of speed necessary to cover the range of velocities it was desired to investigate.

Q. That is from four to seven feet per second?

A. Four to seven feet per second, which corresponds to

the range of velocities reported to have been encountered at the International Bridge in the deeper spans.

Experiments were also tried upon quarter inch and 3/8 inch rods, and upon 3/8, 3/4 and inch pipe, in order to ascertain the effect of the water upon the surfaces of different size; and also the inclination which a circular,—particularly the inclination which a circular rod of metal would take at various velocities. And as suggested by me during the examination of Mr. Shenehon, it was found that the 3/8 inch rod would stand more nearly straight than the quarter inch. In other words if a 3/8 inch cable and a quarter inch cable were hung from the rail of the International Bridge, into the water of the Niagara River, the quarter inch cable would drift further down-stream than would the 3/8.

Q. Just let me ask you a question: Do you know of any further precaution which you could take, or any other experiments which you could make to better determine the forces necessary to hold the meter?

A. There is no better or more accurate way of determining that force, except to go to the site where the observations were actually made and establish a dynamometer apparatus and measure the force there instead of measuring it in the laboratory.

The dynamometer is an expensive piece of apparatus, and it would involve a large expense to make such a test in the field.

Whatever inaccuracies there would be in this test, or inapplicabilities, they would be the same ones as apply to the rating of meters in still water and using that rating to determine their action in running water; as, if one program is legitimate and proper then the determination of the force required to hold the meter when being dragged through the water at a given speed must coincide with the force which would be required to hold the meter if the water were running past it at the same speed.

Q. Will you give the results of your experiment, Mr. Williams?

A. The results of these experiments show that in a current such as exists at the International Bridge in spans 4 and 5, a B meter on the end of a quarter inch cable would drift 25½ feet below the plane of the point of support, if it were not restrained by a counter weight, which is something more than twice the distance which Professor Shenehon arrived at as the result of his computations, and as testified to by him.

Q. According to these experiments, what would have been

the location of the A meter at the index in spans 4 and 5, International Bridge Section, under the conditions referred to by Mr. Shenehon when last on the stand?

A. The A meter at the index point in spans 3 and 4 would have been either just on a line with the lower end of the piers or below them. There is some uncertainty as to the exact position of the lower end of the pier at this depth. But from the best information that I have been able to obtain, I would say that the meters would be below it.

Q. And what would have been the result of that condition?

A. The meter would have been in water which was traveling at a lower velocity than that between the piers, for the reason that the section of the river in which the meter was located would be wider by the width of the piers than that between them. The result would be that the reading of this meter would be less than it should have been or would have been had its location been as assumed between the piers, and when this velocity is multiplied into the area between the piers, the result would be a discharge lower than the actual.

Q. How about the B meter on coefficient work in these spans?

A. The B meter when used on coefficient work had applied to it the guy with the weight, as testified to by Mr. Shenehon; and as we are not informed and Mr. Shenehon was not able to tell to what extent the cable was drawn upstream at the surface for the several positions, we cannot establish with certainty the position it occupied at all points in the vertical. But if the meter were drawn up to the full extent possible by the cable, it would have been below the piers at all points below 35 feet. And if it were drawn up as one would naturally suppose by the amounts indicated upon the curve which Mr. Shenehon had computed as establishing the position of the meter, it would then have been below the piers at all points below about 27 feet.

Q. This calculation as to the position of the meter is made with reference to the weights and everything that the meter had on it, as described by Mr. Shenehon?

A. It is.

Q. What was the width of spans 4 and 5?

A. That is the channel width? In the report of the Chief of Engineers for 1900, page 5328, the width of span 4, is given as 234.2, and of span 5 as 235.8 feet.

Q. The piers, what is their width?

A. The width of piers is given by Mr. Stewart in the paper

already referred to, and concerning which Professor Shenehon testified that he would have no reason to doubt the accuracy of the statement there, as 13 feet in width (pp. 3302-3).

Q. Are spans 3 and 4 similarly affected by drift?

A. Span 6, next to the pier between it and span 5 would be affected practically the same as spans 4 and 5.

In span 3 the effect would be materially less, and it is somewhat questionable as to whether the drift in that case would actually carry the meters below the line of the pier, although it is possible it might do so in the coefficient work at some points.

Q. By how great a percentage would the area of the sections in spans 4 and 5 be increased by the drift of the meter below the piers?

A. That is a question that it is somewhat difficult to answer positively as it does not appear that the information regarding these piers shown upon the cross sections of the river as published in the report of the Chief of Engineers for 1900, and in the report of the Board of Engineers on Deep Waterways is sufficiently precise to permit of a close estimate. The width of the piers as stated, which Mr. Stewart says are water width, is 13 feet. And he says: "The piers have a batter on the sides of about one in 24." This would mean that in 24 feet depth of water the piers would be wider by two feet than at the surface.

At a point about 12 feet below the surface, the piers widen as shown by the cross sections already referred to, and as indicated by the plans of the bridge which I have been able to obtain from the Bridge Engineer of the Grand Trunk Railway. And the lower portion below that depth is indicated on these cross sections as being—

Q. You are referring now to what?

A. I am referring to the report of the Board of Engineers on Deep Waterways and the report of the Chief of Engineers for 1900. These would indicate that the width of the piers below a depth of from 12 to 20 feet is in the neighborhood of 25 feet. The plan of the bridge, however, furnished by the Bridge Engineer of the Grand Trunk Railway, does not indicate any such width at that point but would indicate that the piers are possibly, at the outside, 20 feet wide down to the point where they rest on the caisson at the bottom of the river.

The three piers would have the effect of increasing the width of spans 4 and 5 somewhere between 40 and 50 linear feet.

Q. That is at the point where the meters would rest below the piers; would increase that, wouldn't it?

A. Yes, at the points where the meters would be below the piers, the width would be increased by somewhere between 40 and 50 feet, the effect of which would be to increase the cross section somewhere between eight and ten per cent.

Q. From these experiments that you have made and the deductions that you have just indicated, do you have any opinion as to whether or not an error would be introduced into the discharge measurements of the Niagara River at the International Bridge Section? If so will you state what error might result?

A. This would introduce a very decided error into the discharge measurements. In the first place, the velocities obtained in the lower half of the vertical on coefficient work would be too small, thereby reducing the mean velocity, reducing the apparent mean velocity, and correspondingly the discharge.

This error would be present if the meter at the index point had been within the piers, but with the meter at the index point lower down-stream, this error is multiplied by the percentage of error that is introduced on account of the position of the meter at the index point, so that it seems from such approximate calculations as we can make with the data in hand that there is a possible error here of somewhere between 3 and 6 per cent. in the discharge of the Niagara River at the International Bridge.

Q. That is from that source alone?

A. From that source alone.

Q. What did you have to do with the experiments on flow in the Sanitary Canal during February and March, to which Mr. Wisner referred?

A. In conjunction with Mr. Wisner, I planned the scope of the investigation, assisted in the selection of locations for observing, in conference with Mr. Wisner, Mr. Blanchard and Mr. Ramey; and furnished a part of the apparatus used and a party of five men who participated in the test, and I have had a general oversight of the computations and reductions of the data obtained.

Q. Will you describe just in general the plan of the experiments?

A. The experiments contemplated starting with a flow in the canal of about 4,000 cubic feet per second well established, and suddenly increasing the discharge at the lower end of the canal to about 10,000 cubic feet per second and observing the

change in the elevation at the several gages along the canal, and also the change of discharge by current meters located at selected points along the canal. It was intended to continue the discharge of 10,000 cubic feet per second at the lower end of the canal until a flow of that amount should be established throughout the canal.

Q. What was the equipment used, and who were the observers, and what can you say as to their qualifications?

A. For the experiments on March 8-9, Mr. Murray Blanchard, to whom reference has several times been made, was in charge of the current meter measurements.

I may add to what has previously been said that Mr. Blanchard was also in charge of the measurements of the St. Lawrence River at the Couteau Rapids, which were performed for the Canadian Light & Power Company, in which not only the flow of the main stream was measured but the flow of its several branches, some eight or ten in all in separate channels between the islands through the Rapids.

Q. He was in charge also of the test that was made on February 22, was he not?

A. He was also in charge of the measurements that were made on February 22. Mr. Blanchard is a graduate of the University of Michigan and entered the employ of the Lake Survey where he remained for several years on discharge measurements, when he went to New York and was engaged under Mr. Noble on the Pennsylvania Tunnel work. From there he went to the work on the St. Lawrence; then went on some construction work in the South and from there came to the District where he is employed.

Q. You consider him to be a careful and a competent man to do this kind of work?

A. I do. He is very careful and received careful training in Lake Survey methods, and was regarded by his superiors there as a thoroughly reliable assistant.

Q. Now who was at the other places?

A. At the Power House—

Q. This was on March 8th?

A. Yes. The general manipulation of the gates including the Bear Trap Dam was under the direction of Mr. E. L. Cooley, who has been for many years, in fact I think since the inception of the Drainage Canal work, connected with the Sanitary District.

Q. In the Engineering Department?

A. In the Engineering Department, and has made prob-

ably more studies of the hydraulics of the canal than any man living.

As my personal representative at the Power House, in this test was Mr. R. K. Holland, my Principal Assistant Engineer, and Mr. William Rennie, my Assistant Electrical Engineer. Mr. Rennie particularly had charge of the observations of electrical output and manipulation of gates on the turbines. Mr. Holland made general records of all the rest of the manipulations at the Power House and as reported from the Bear Trap Dam.

At the Lockport Discharge Section, Mr. R. H. Burke, of the Sanitary District staff, who has been working on current meter measurements under Mr. Blanchard since his connection with the District, was stationed with a Haskell Meter which was operated from a cable suspended across the canal.

At Lemont, Mr. George E. Haggas, of my office staff, with a Haskell Meter, was stationed there. This meter was operated from the Bridge at the same point and under the same conditions as in the experiments by Mr. Moore testified to on behalf of the Complainant. Mr. Haggas was Mr. Blanchard's Principal Assistant on the measurements of the discharge of the St. Lawrence River, to which I have referred, and has been for some time connected with my office where he has had more or less to do with hydraulic work.

At Willow Springs, a Harbor Price Meter was operated by Mr. Herbert Ripley and Mr. J. T. O'Connor, of the District staff, the meter being operated from the Bridge. Mr. Ripley is a graduate of the Civil Engineering Department, University of Michigan, and has been connected with the District for several years.

Mr. O'Connor is an employee of the District and has been assisting Mr. Blanchard and Mr. Ramey in hydraulic work on the Canal.

The next location was at Robey Street where Mr. H. P. Ramey had a Harbor Price Meter which was operated from the bow of the steamer Robert R, being suspended from a boom six feet clear of the bow. The Robert R draws between three and four feet forward when loaded, as she was on this occasion.

Mr. Ramey has been connected with the District for some six or seven years I think. He is a graduate of the University of Michigan and while a student participated in considerable hydraulic work under my supervision, and has done a considerable amount of current meter work for the Dis-

trict. He has also made gagings of the canal by means of floats.

At Loomis Street, Mr. J. R. James, from the staff of my office had a small Price Meter which was operated from a six foot boom from the bow of the gasoline launch Thos. A. Mr. James is a graduate of the Engineering Department of the University of Michigan, and for something over two years, I believe, was connected with the United States Lake Survey Office at Detroit, and since that time for a year or more has been connected with my office.

At Dearborn Street, Mr. L. E. Ayres, my office Engineer was located with a small Price Meter, which was operated from the Bridge. Mr. Ayres is a graduate of the University of Michigan in civil engineering and has been on hydraulic measurements under me intermittently for the past six years; has gaged several small streams both by current meters and by floats, and participated in hydraulic measurements with the Pitot Tube, and the measurement of water over weirs.

Q. He has also participated in the experiments there in the naval tank?

A. Has also participated in the experiments in the naval tank and in the computations involved in the preparation of material for this case.

On February 22, Mr. Blanchard was in charge of the meter party; at the Power House, Mr. E. L. Cooley was in charge and Mr. R. K. Holland of my staff was there to take personal notes and check the observations of the various operators and performers.

At Lemont Mr. R. H. Burke was located with a Haskell Meter which was operated from the Bridge.

At Summit, Mr. Ramey was located with a Price Meter which was operated from the Robert R; and at Dearborn Street Mr. Haggas was located with a Haskell meter which was operated from the Bridge.

Mr. Blanchard devoted during this test most of his personal attention to the work of the Haskell Meter at Dearborn Street.

Q. For how long a period were the experiments continued?

A. A discharge of approximately 10,000 cubic feet per second was maintained at the lower end of the canal for about 14¾ hours, when it was reduced to about 8,000 cubic feet per second and continued at that for two hours more, by which time the demands of service required that the flow be brought down to a minimum to store water for the day load. During

the first 2¾ hours, 5,000 cubic feet per second was discharged at the Bear Trap Dam and during the next two hours about 2300 cubic feet per second was discharged there.

Q. On what date was this?

A. This was on March 8th.

Q. What success did you have in establishing a flow of 10,000 cubic feet throughout the canal and the Chicago River during the period which you mentioned?

A. It was not possible to establish a flow of 10,000 cubic feet per second throughout either the canal or the Chicago River during the period of the observations.

Q. What flows were you able to establish in that time?

A. At Lockport, the station being located 13,000 feet (2.46 miles) above the Power House and about 3,000 feet (3/5 miles) above the Bear Trap Dam, where the water was being withdrawn during the first five hours of the test, a discharge of 10,000 cubic feet per second was established about seven hours after the increased flow was started.

At Lemont, 37,200 feet further up (being 9½ miles from the Power House) a flow of 10,000 cubic feet was established about three hours later, or 10 hours after the opening of the gates.

At Willow Springs, 39,500 feet above Lemont and 16.9 miles from the Power House, the highest flow attained was about 9300 cubic feet per second, which was reached four hours after 10,000 at Lemont, seven hours after 10,000 at Lockport, and fourteen hours after the opening of the gates at the Power House.

At Robey Street, 68,500 feet above Willow Springs and 29.9 miles from the Power House, the highest flow established was about 8400 cubic feet a second, which occurred about nine hours after the flow of 10,000 cubic feet at Lemont and 12 hours after that at Lockport; and about 19 hours after the opening of the gates at the Power House.

At Loomis Street, 5650 feet above Robey or 31 miles from the Power House, the highest discharge observed was about 7200 cubic feet, which occurred about 11 hours after the 10,000 at Lemont, 14 hours after the 10,000 at Lockport and nearly 21 hours after the opening of the gates at the Power House.

At Dearborn Street, 22,450 feet further up, 35.2 miles from the power house, the change began about four hours after the opening and the flow increased to 7300 cubic feet per second at midnight or about 11¾ hours after the same discharge was observed at the Lockport meter.

Q. How would you interpret the results of these experi-

ments as to the time it would take to establish a flow of 10,000 cubic feet per second in the canal starting with a base flow of 4,167 cubic feet per second by opening to a capacity of 10,000 cubic feet per second at the lower end?

A. These tests indicate that such a flow could not be established at Robey Street in less than 24 hours.

Q. You spoke of the approximate flow of 10,000 cubic feet per second at Lockport. How near 10,000 cubic feet do you consider that it was during the time that you mentioned?

A. I think it might be in error five per cent. either way, that is a total error of 10 per cent. in there; possibly a part of the time a little bit more.

Q. You had a check on that did you not at Lockport?

A. The meter records at Lockport and Lemont agree with the Power House records within about 500 cubic feet a second for the period from 10:00 P. M. of March 8, to 1:00 A. M.; the Lemont record being intermediate between the Lockport and Power House. If the Lemont record were right, it would indicate that the Power House might be in error $2\frac{1}{2}$ per cent.

Q. Do these experiments, tests, have any bearing on the discharge measurements of the outlets of the Great Lakes as carried on by the Lake Survey? If they have, will you state what your conclusions are with reference to that matter?

A. Yes. These experiments reproduce on a large scale the condition which exists on the rivers flowing out of the Great Lakes when either the lake at the lower end, as in the case of the St. Clair and the Detroit, lowers or the lake at the upper end, as in the case of any of the rivers, rises. A wave is immediately set up which passes down the river, and which has been used to determine the time that the discharge at the gaging station would correspond to that due to the changed elevation of the lake. These investigations prove very conclusively that the full effect of a change of stage of the governing body of water upon the flow past a given section does not coincide with the time of the change of the gage height at that section.

Q. That is the travel of the crest as it has been called?

A. The travel of the crest. That the travel of the crest gets there very much sooner than the increase of discharge does; and that the change of discharge coincident with the surge or with the passage of the crest may be anywhere from 10 to 80 per cent. too small depending upon the location for distances from the governing change of three miles or more.

Q. What is the essential distinction between the methods used by the Lake Survey and the witnesses who have been produced by the Complainant in this case of relating discharge measurements, and the method used by you, and what bearing do the experiments of March 8-9 on the Drainage Canal have on each?

A. The theory of the Government Engineers has been that at the gaging station the discharge changes corresponding to a change of elevation of the governing lake are completed coincidently with the surge of the gage or the passage of the crest of the wave caused by the change in the lake elevation; and that the time interval between the change in the lake elevation and its corresponding discharge is measured by the time of travel of the wave set up by the change, over the intervening distance. The fallacy of this assumption is proven by the canal tests wherein, for example, a flow of 10,000 cubic feet per second at Lemont did not produce a flow of more than 9300 cubic feet at Willow Springs in six hours, though according to the testimony of Mr. Moore (record printed page 2880) the change of elevation accompanying a change of discharge at Lemont, was observed at Willow Springs within about 30 minutes.

This being a regular channel, 162 feet in width and over 22 feet in depth, approximately straight, and with smooth vertical sides.

The theory upon which I have proceeded has been that the only way to establish a connection between the discharge and the lake elevations, from the observations in evidence, was to take periods when there was little change in the lake elevation, and therefore the mean elevation could be taken as representative of the condition for the whole period, and to compare this mean elevation with the mean of the discharges taken during that time.

I have also considered the fact, shown by the canal experiments, that a very much longer time must elapse between the occurrence of the lake elevation and the discharge corresponding than has been allowed by the complainant.

Adjourned subject to notice.

GARDNER S. WILLIAMS resumed the stand and testified further as follows:

Cross-Examination by Mr. Hopkins.

Q. Mr. Williams, in speaking of ice effects, you spoke of it as also affecting the canal. If as a matter of fact the same amount of water, as for instance 10,000 cubic feet a second, is taken at the Power House, it does not make much difference does it, even though it may require more slope to get it over, you are getting the 10,000 cubic feet of water, are you not?

A. If I understand your question to mean if 10,000 cubic feet of water is taken in the winter and 10,000 cubic feet of water is taken in the summer, the same quantity of water would be taken from the lake at both times, my answer is yes.

Q. If you are taking a certain amount of water in the canal, then the ice effect in the canal does not make any difference as to your effect on the level of the lake?

A. If you are taking a certain amount of water through the canal, the question of whether ice is there or is not, or anything else, does not make any difference in the quantity of water which is taken.

Q. Does it make any difference in the effect upon the lakes?

A. If it is taken from the lakes, I do not see that it would.

Q. Then it does not offset any ice effect in the St. Clair or any other rivers, if they are taking that amount of water?

A. On the assumptions that you are making, it would not.

Q. And in this case questions have been asked as to the effect of a certain diversion at Chicago, or the named amount of water, so many cubic feet of water per second; have not all the questions been on that basis?

A. Of various diversions at Chicago, yes.

Mr. Adcock: It is the effect of the diversion at Chicago.

Mr. Hopkins: Of a certain amount of water per second.

Mr. Adcock: Of the ultimate effect. There is not any theory about it, it is the ultimate effect which you have taken. You seek to enjoin us from taking the amount which we are taking.

Mr. Hopkins: Q. Now you discussed Mr. Sabin's results in 1901 and on page 3318 of the record (printed record, 3506) you said that in the month of February, 1901, the surface of

Lake Erie fell .24 feet. What was the source of that information?

A. The report of the International Waterways Commission, if I remember correctly.

Q. Have you that report?

A. I have not at the present moment.

Q. Have you got it where you can produce it?

A. No, it is not here. I think there is probably one in the office somewhere. I will see if I can find it.

Q. Have you that report now?

A. I have.

Q. Page 139?

A. (Referring to same.)

Q. Do you know how they determined the elevation at the first of the month say and the last of the month?

A. I do not.

Q. What would you regard as a proper way of getting the elevation for a certain time, say the first of February, 1901, of Lake Michigan-Huron?

A. If I wanted to be very accurate about it, I would take the mean elevation of all the gages of which I had a record on that day.

Q. The same with Lake Erie?

A. The same with Lake Erie.

Q. Do you know that the figure as put down in that report to which you referred showing the elevation for say the first of February, is the mean of the average for January, 1901, and of February, 1901?

A. I do not.

Q. Can you verify that, see whether that is the case or not?

A. What is the question?

Q. (Question read.)

A. In the present instance, the sum of the mean elevations for January and February is 235, and the elevation given for the first of February is 118, which is approximately ½ of the means of the two.

Q. Can you satisfy yourself from the data before you as to whether or not that was the method used throughout?

A. From random comparisons, it would appear that that is the method or that that may be the method.

Mr. Adcock: I would like to submit that it would be impossible to determine that a particular method was used, simply by making a comparison and finding that you might

get a result in that way. It is a kind of hit or miss proposition.

The Witness: I will say that it seems a fair inference that that was the method. I do not want to say that it was.

Mr. Hopkins: Q. If that method was used, it would hardly have very much value as far as picking the elevation for a certain day is concerned, would it?

Mr. Adcock: I object to the question, on the ground I think it is an unfair question to ask the witness, without calling attention to some statement in the report of the International Waterways Commission, or some evidence, which would indicate the method which they did use in determining the elevation of the water surface of Lake Erie for those different days. It would seem to me that the method which the Government's counsel asks the witness to use in determining how the elevation was obtained is entirely improper, because it would seem to me to be a hit or miss proposition. Unless you knew what the elevations, mean elevations were for the days mentioned, and make comparison in that way, it would not be of any value.

Mr. Hopkins: If you admit that, that is all I ask in that last question.

A. Just what is the question?

Q. (Question read as follows: "If that method was used, it would hardly have very much value as far as picking the elevation for a certain day is concerned, would it?")

A. It would depend upon the location of the day. If the day were midway between the means, I would think that this method would probably be as accurate as taking the reading of a single gage at a single time on that day.

Q. How about taking the mean of all the gages on that day?

A. A mean of all the gages would be, I think, a more accurate method than taking the mean of the month each side.

Q. You mean between the average of two months would not show at all if there was a sharp rise half way between, would it?

A. It would show part of it.

Q. Possibly only a small part?

Mr. Adcock: I object to this question on the ground it does not take into consideration the purpose which the International Waterways Commission had in mind in determining the elevation for those times.

Mr. Hopkins: Regardless of what the International Waterways Commission had in mind, the witness has taken certain

figures in that report and used them for comparison for a particular time, to show a fall or rise between the first and the last of the month, when in showing that, it does not accurately show or attempt to show the elevation at the two days which he is trying to use the rise and fall for.

Mr. Adcock: I understand in various considerations here, which we have taken up with reference to the hydraulics of the different lakes that the daily mean would not be of any particular value as compared with the monthly mean or the yearly mean. It depends upon the purpose for which you wish to use the data.

Mr. Hopkins: Exactly, it depends upon the purpose, but when you compare one day with another one you do want those days, rather than the average when they are all ironed out.

Q. (Question read as follows: "Your mean between the average of two months would not show at all if there was a sharp rise half way between, would it? A. It would show a part of it. Q. Possibly only a small part?")

A. As to how much it would show would depend altogether upon the distribution of the changes of elevation throughout the periods considered. If you want to give a particular case, I will try and figure it out for you and try and tell you how much the means would show.

Q. Do you consider that taking your figures from tables computed in that way, that you can get a comparison of one day with another day, with any great degree of accuracy?

A. I would expect that there might be considerable error in the elevations for any single day; but I think that as showing the change of elevation over a period of 30 days, it would be very accurate.

Q. But the way you get your change of elevation over 30 days is comparing the first of the month and the last of the month, so that you really do take two particular days, do you not?

A. What it appears we are getting for the change of elevation over 30 days is comparing a period of two months at which the day considered is the middle day with a period of two months in which the day considered is the middle day; and I think that is a quite accurate way of getting at this elevation.

Q. Will you take from this same table Lake Erie from the Buffalo gage, using the same method?

A. It would give you a change of .39 as compared with a change of .24 if you used the Buffalo gage.

Q. How many inches does that .39 represent?

A. .39 represents about five inches, $4\frac{1}{2}$, $4\frac{3}{4}$.

Q. That would make about two inches difference, would it not?

A. About an inch and $\frac{3}{4}$.

Q. You might have a certain average for say the month of January in any one year, a certain average for the month of February, and they might be very close together and still on the first of February have an elevation quite a little higher or quite a little lower than that average, could you not?

A. I think it is not likely considering the whole lake. You might at a single gage.

Mr. Adcock: That is there might be oscillations?

A. On one gage you can get anything. For instance you have the comparison of Buffalo and Cleveland; the Buffalo gage is notoriously unreliable, on account of the effect of winds and other things which raise the water or lower it at Buffalo, whereas Cleveland being near the waist of the lake as it is is much more dependable.

Mr. Hopkins: Q. You took one gage though didn't you, the Cleveland gage?

A. I took the one which the International Waterways Commission used; adopted their figures as being the result of the study of experts on the subject, presenting the matter as they believe it to be, I assumed, correct.

Q. Did they use it for any such purposes as you did?

A. Well they put it here and they spoke of the change in lake elevation during the month. It is given here, storage in lake Erie for the month, right straight along. It is evidently based upon this first column. I think they used it for exactly the purpose I used it.

Q. Are they not average values?

A. That is given as the storage for the month. Now I think as indicating a change of elevation for the month, this method is certainly as accurate as taking a single daily reading would be.

Q. Of a single gage?

A. Of a single gage.

Q. But not if you took the mean of all the gages of the lake?

A. It would depend on how many you had. If you had four, I think you would get more accurate results, that is to say if you had Amherstberg, Buffalo, Cleveland, and a gage on the Canadian shore.

Q. We have at least three of those?

A. You have three. You need the fourth to balance the other three.

Q. There is one at Toledo?

A. Toledo does not help you. You can use that in place of Amherstberg, if you want. Of course Amherstberg, must have a correction to bring it down to the level of Lake Erie.

Q. How many do you have in Michigan-Huron?

A. Michigan-Huron you have one at Harbor Beach, one at Milwaukee ordinarily. Of course there are some others; one at Chicago that might be used, and there is one at Mackinac. I do not know how accurately that one is observed. Of course there is one below the locks at the Soo, but that is too far away from the lakes.

Mr. Adcock: Q. Is that under the jurisdiction of the lake survey?

A. I do not think it is under the jurisdiction of the Lake Survey regularly.

Q. It is kept by the Government is it not?

A. I do not know just what the standing of the gage at Mackinac is. I know there has been one there at certain times.

Mr. Hopkins: Q. Then you would not consider taking the gage readings on a particular day at one gage as a highly accurate method of getting the rise or the fall during the month?

A. No, I would not.

Q. You just stated you consider this averaging scheme as accurate as that?

A. I think it would be.

Q. Now referring to page 129, will you take Lakes Michigan-Huron and from the gage at Milwaukee instead of the one at Harbor Beach see what result you would get for the change in elevation for the month of February, 1901?

A. You would get a raise by the Milwaukee gage of .195.

Q. At Harbor Beach there is no engineer officer there in charge, is there?

A. Harbor Beach?

Q. Yes?

A. I do not know.

Q. In the winter season?

A. I do not know.

Q. You do not know whether it is accurately watched, or not, or whether it freezes up or anything of that kind?

A. Well, considering the testimony of Mr. Shenehon that when the records from Harbor Beach were available he would

prefer them to Milwaukee, I would hardly assume that such was the condition.

Q. Was that statement concerning the winter season?

A. That statement was concerning yearly averages. I presume that included the winter; if I remember it rightly. I will not be positive that I remember the exact context.

Q. Did it not have to do with the discharge of the St. Clair River, being the gage nearest the discharge?

A. I think not.

Q. And also with reference to the time of measurements of the St. Clair River, which were usually in the summer?

A. That was not my recollection; that is not my recollection at this time.

Q. For a period of 30 days, would you ordinarily expect the average elevation from one gage at one part of the lake to be very different from another part of the lake?

A. Why I would expect them to be about what the records show. There are considerable variations.

Q. Do you not have any independent opinion regardless of the records; in case anyone were out of order, poorly kept, you could not detect that from the results?

A. I have a very decided opinion as to the accuracy of the gage measurements on the Great Lakes; and that is that it is altogether insufficient to detemine the effects of such diversions as we are considering in this case, with precision.

Q. Inaccurate for any other purpose, you think?

A. I think they are inaccurate for determining the elevations of the lake within the degree of precision that is necessary to determine the effect of the diversion in this case.

Q. And all the more so, inaccurate for taking a particular day as against another particular day to discredit actual measurements?

A. I would consider that the gage readings are about as accurate as the current meter determinations.

Q. Whether it was working or not?

A. We are talking about averages. I know of a case under the eyes of a civilian officer of the Engineer Corps, if there is such a term and I suppose there is, where gage readings were reported daily and the observer did not go within 600 feet of the gage. The records introduced in his case show again and again the impossibility of their accuracy. I called attention to some of those in my former testimony.

In this comparison, we have taken the information that is available. If the Lake Survey or anybody else has anything that is any better, we will be glad to have them produce it

and we will revise our opinions in accordance therewith. But so far as the conclusions in my testimony are concerned, they were based upon what I believed to be the best information at hand.

Q. If you found the best information at hand did not accurately show the two days you were comparing, would you still insist upon using it to establish the real truth?

A. No, I do not think the real truth is established by these gage readings or by meter discharges.

Q. I understand you do not have that great opinion of meter readings, but I was asking merely as to your method of trying to discredit it by something that is really inaccurate.

A. Here are two things coming from the same source, the officers of the United States Government. They are both presented in official reports, and I compare them for what they are worth. I state the source of my information and what the evidence there set forth or the statements there set forth seem to show.

Now, I do not vouch for the correctness of that showing or the correctness of the statements behind it. I simply have taken, as I say, two reports presumably of equal reliability and have shown their inconsistencies. One or the other is wrong; I do not know but both are.

Q. Although made for entirely different purposes, and that this method of averaging to get the elevation at a particular day is something you have already testified is very inaccurate?

A. Oh, I don't know as I said it was very inaccurate.

Q. I understood you to say it was as inaccurate as the readings of one particular gage, which you said were very inaccurate.

A. No, I think not. I do not think I used the words "very inaccurate" in there, because I do not think it would be.

Q. Would you consider the International Bridge and under that as a good place for working with a magnetic instrument?

A. It would depend somewhat how far under it.

Q. Suppose at the water surface?

A. If you wanted to determine a true north, I would say not. But I do not see that it would affect materially the vibrations which a needle would have.

Q. Supposing at the .2 or .4 depths?

A. My observation of the magnetic needle in the presence of a fixed lodestone, or body of iron, has been that it assumes

a certain position which it tends to retain although it is not the true north, and except when a locomotive or a train of cars was passing over the bridge, I can see no cause for the presence of the bridge creating a vibration of the needle.

Q. If you got further away from the bridge, say below it, would it have any effect?

A. It might change the direction at which the needle would point, but I can't see that it would affect the vibrations of it. That is I can't see why a needle should vibrate through say 90 degrees because the bridge was there, whether it was at the .1 depth or .9 depth, or any other depth.

Q. Will you describe the instrument as used to determine the direction of the current?

A. It consists of a needle floating in a vessel, and by means of electrical contacts, the position of the needle is repeated to an instrument above. That is a hand on a repeater is caused to travel across the dial, and at the time of coincidence in direction of the two needles, the hand traveling across the dial stops. That is as I recall the action of the apparatus.

Q. Considering nothing but the fluidity of the water as between 60 degrees and 33 degrees, what effect do you think it would have flowing over the weirs at Cornell, say where the flow was about 500 cubic second feet?

A. As to what?

Q. The difference it would make?

A. In the discharge for a given head?

Q. Yes?

A. Possibly one per cent.

Q. For the Niagara River?

A. Probably about the same.

Q. Did you ever make any observations at Cornell in regard to that matter?

A. We had some made, yes.

Q. Over weirs?

A. Yes.

Q. With no change of condition except the temperature?

A. That was the only change.

Q. Will you describe the tests that were made under your direction in the tank at Ann Arbor, in regard to the resistance of cables with various weights on them, whatever that test was that was made?

A. The plant at Ann Arbor which was utilized consists of the naval tank which is about 300 feet long, 20 feet wide, 22 feet wide, I believe between walls, and about 10 deep as I recall.

On this there runs a car which has a platform about 20 feet square. This car is driven by electrical apparatus and carries a dynamometer. In these tests the meters were first suspended on a rod which was held vertically in the water and the pull of the meter and rod was taken up on the dynamometer; the car being caused to travel the length of the tank so as to get certain speeds over the middle 100 feet.

The meters were then removed, and the travel was made with the rods, so that the amount of resistance that was due to the rod could be separated from that due to the meter.

At a velocity of 7 feet a second, the A meter with a 3/4 inch pipe support offered a resistance of 17 pounds. At a velocity of 6.15 feet per second, the same meter offered a resistance of 13.22 pounds. At a velocity of 4.88 feet per second, the resistance was 8.15 pounds. For a velocity of 4.16 feet per second, the resistance was 6 pounds. For a velocity of 3.1 feet, the resistance was 2.9 pounds.

This was supported upon a 3/4 inch pipe. The resistance of the pipe alone, at a velocity of 7.18 feet the resistance was 5.55 pounds. At a velocity of 6.27 feet, the resistance was 4.4 pounds. At a velocity of 4.92 feet the resistance was 2.75 pounds. At a velocity of 3.97 feet, the resistance was 1.8 pounds. At a velocity of 3.15 feet, the resistance was 1.1.

For the B meter, which was mounted upon a one inch pipe, for a velocity of 7.1 feet, the resistance was 15.95 pounds. For a velocity of 6.65 feet, the resistance was 14.1 pounds. For a velocity of 5.48 feet, the resistance was 9.75 pounds. For a velocity of 5.04 feet, the resistance was 8.15 pounds. For a velocity of 4.5 feet, the resistance was 6.6 pounds. For a velocity of 3.95 feet, the resistance was 5.12 pounds. For a velocity of 3.18 feet, the resistance was 3.15 pounds. For a velocity of 2.16 feet the resistance was 1.39 pounds.

The resistance of the 1 inch pipe alone: For a velocity of 7.12 feet, it was 7.65 pounds. For a velocity of 6.2 feet, the resistance was 5.95 pounds. For a velocity of 4.97 feet, the resistance was 3.95 pounds. For a velocity of 4.05, the resistance was 2.9. For a velocity of 4.02, the resistance was 2.85. For a velocity of 3.12, the resistance was 2.3 pounds.

I may say that the observations with the meter included the meter with its lead, so that subtracting the pipe from the meter and pipe gives the resistance of the meter and the lead.

Adjourned to Thursday, June 18, 10:30 A. M.

Thursday, June 18, 1914, 10:30 A. M.

GARDNER S. WILLIAMS resumed the stand and testified further on cross-examination as follows:

The Witness: I think there was a question pending.

Mr. Hopkins: Q. Did you finish the answer to the question Mr. Williams?

A. I think not.

Q. Will you go ahead and complete it?

A. If I recall, I had finished the experiments on the A and B meter and the one inch and 3/4 pipe, so that it is possible to get the pressures on the meters and their weights.

Q. Were the meters attached to the cable?

A. During these cable tests?

Q. Yes?

A. No, not during the cable tests. The meters were attached to the pipe. The resistance of the pipe, meter and weight was taken. Then the meter and weight were removed, the resistance of the pipe alone was taken and subtracting the resistance of the pipe from the resistance of the—

Q. It was not attached then directly to the cable?

A. Let me finish: Then the resistance of the meter and weight was obtained by subtracting from the combined resistance of the meter, weight and pipe, the resistance of the pipe.

Then the cables with the weights attached were rated for different lengths by subtracting one length from another the weight and the excess length of cable was eliminated—the weight and the common length of cable was eliminated, and the effect of the remaining length was obtained.

Q. The A meter was attached to a 3/4 inch pipe, was it?

A. Yes.

Q. What was the method of that attachment?

A. The staff of the meter was attached rigidly to the pipe, so as to maintain the shaft of the meter in a vertical position.

Q. How was the pipe attached to the car?

A. The pipe was supported on a frame which was operated with a parallel motion, so that any vertical pressures would be taken up in the frame, and the dynamometer was attached to measure only the horizontal pressure.

Q. The pipe was vertical, and rigidly attached to the car?

A. No, the pipe was raised vertically and attached to this parallel motion which was free to move back and forth

parallel to the position of the car, and the amount was measured by the dynamometer, which measured the amount of pull. The dynamometer is a separate machine mounted on a car; the frame of the scaffold standing vertical.

Q. But the pipe was held rigidly vertical?

A. The pipe was held rigidly vertical, and so was the staff of the meter.

Q. How far was it from the point of attachment of the pipe to the surface of the water?

A. About somewhere around 4 feet. I haven't the note book here and I do not remember exactly. The meter was run between 2 and 3 feet below the water surface.

Q. Under those circumstances you got considerable vibration in the pipe, did you not?

A. No we did not. That was one of the things we looked after, having discovered the effect of the vibration previous to running the meters.

Q. How deep was the axis of the meter below the surface of the water?

A. I say it was somewhere around 2 feet. I will not be certain as unfortunately I have not the notes with me.

Q. Then there was a length of about 6 feet of pipe involved?

A. No, I do not see where you get 6 feet.

Q. I understood it was 4 feet from the place of the attachment to the surface of the water and about 2 feet below the surface of the water to the axis of the meter?

A. I misunderstood your question. The place of the attachment was close to the surface of the water. The dynamometer as built is intended primarily for measuring the resistance of models of boats and the point of attachment of the boats to the dynamometer is 2 or 3 inches above the surface of the water, but our point of rigid support for the apparatus to be measured was a foot above that level and further down the pipe extended to the meter a length of somewhere around 3 feet of pipe, between 3 and 4.

Q. The motion of the meter then was even, without wabbling through the water?

A. Yes, reasonably so, about the same as it would be in an ordinary stream, and the same as it is in rating meters in the tank.

Q. What freedom did the meter have to adjust itself to the direction of the current?

A. It was free to move about its trunnions in a vertical plane and about its ordinary axis in a horizontal plane, so

that it had the same freedom it has when in a stream aside from that it acquires from the twisting of the cable which I think it practically never does.

Q. Did you have any ball bearings?

A. It was the ordinary meter as it is furnished by the Ritchie-Haskell Meter Company.

Q. Do you know whether it did have ball bearings or not?

A. I think the vertical shaft—the B meter was the latest type of meter which they turn out. The A meter we had consisted of a body and supports, which is an older make. It is about the same thing that you had on the Niagara, I think, as it was one that I got in 1897, I think.

Q. You did not put any ball bearings in it?

A. We did not put any ball bearings in it. It was as it was built.

Q. How much later type was the new meter, the B meter you had?

A. That was purchased a few weeks ago, that is within the past three months.

Q. Now have you got the plan of the lead you used?

A. I haven't it with me. The lead was shaped as nearly as could be determined by scaling the photograph of the lead used on the Niagara River, and it appears on Plate number 6, next to page 5327 of the report for 1900, and by getting the weight to correspond with the statements as to weight, which is indicated in the same report.

Q. What was the length of the weight?

A. Unfortunately I haven't those dimensions here, but I saw the weight day before yesterday, or rather not day before yesterday but Sunday, and without measuring it, from recollection I should say it was in the neighborhood of a foot in length. I may say that it was cast by extending the weight which belonged with the meter originally; that is by putting on additional weights of the same form, which is a boat shaped body.

Q. What was the breadth as you recall it?

A. It was the same as that furnished with the meter, and my guess would be somewhere about seven inches. I can secure that information and furnish it to you accurately.

Q. Were the two leads used on the two meters the same?

A. Yes, the same leads.

Q. What kind of a tail was used in each case?

A. The tail was a flat plate of wood in both cases.

Q. How long was the tail?

A. Oh, it was somewhere around—let's see, I don't want

to be positive that that tail was used in both cases, that is the one I saw was used in both cases. The tail as I recall it would be about two feet long, possibly 2½; or I will say from 18 to 30 inches.

Mr. Adcock: The tail on what?

A. On the weight. The tail as we used it I think was a little longer than that indicated on plate number 6, just referred to.

Mr. Hopkins: Q. Referring to the photograph which you have just mentioned and from which you got the form of the weight, just what is the length as shown on that photograph from which you reproduced the weight?

A. I will say the position of the lead is such that it is difficult to tell from this photograph just what the length was. The form that was taken was that which was the form of the weight furnished with the meter as purchased in 1897, which was a boat shaped body.

I will say that from this photograph the depth of the weight can be fairly well established, and having that and the width corresponding to the weight that was originally sent with the meter, why the length has to be a certain thing. It cannot be very different.

The photograph to which reference has just been made appears upon page 2461 of the printed record, being in volume 4.

Q. You made these tests at two depths, didn't you, one of eight feet and the other of five feet, to get the pressure on the cable?

A. The length of cable used was eight feet, five feet and two feet.

Q. That was the length of cable used?

A. Yes.

Q. You were getting your differences then on three feet of cable?

A. Getting our differences from six feet; that is we get two differences of three feet.

Q. Did you get a difference from two to eight feet?

A. Yes.

Q. Singly, too, to check with the others?

A. Why yes. All you have to do is subtract your observation for two feet from your observation for eight.

Q. Based on that six foot cable, the difference between two feet and eight feet, what would be the pressure on a quarter inch cable for 10 foot length at velocities of 4, 5, 6 and 7 feet per second?

A. I will have to work those out for you.

Q. About how long will is take?

A. I do not know. It might take half an hour. I was going to give you the observations themselves.

Q. What is the measuring principle on this dynamometer?

A. The dynamometer consists of a vertical lever which is held in a vertical position by calibrated springs in the nature of a spring balance, and a pencil at the top attached to a bar at the top records graphically on a drum rotated by a clock mechanism the deviation of the top of the bar from the vertical; this of course measuring the extension of the spring and thereby the amount of pull that is exerted at the bottom of the lever.

Q. That is it is a spring balance?

A. It is a spring balance, practically.

Mr. Adcock: Q. Was it a good dynamometer?

A. Yes, the spring is the highest grade steel spring as used for indicators in that class of device.

Q. The one that is ordinarily used?

A. Yes, and it is frequently calibrated with known pulls.

Q. And it was used by competent persons?

A. The experiments were made under direct supervision of Professor Sadler, who has employed that apparatus for measuring the resistance of ships and other bodies when drawn through the water, in order to calculate the horse power required and so on for driving ships of different models. It is similar in construction to that used by the United States Government in their dynamometer experiments at Washington in their naval tank; similar to that used by Professor Durand at Cornell, although I think a little more direct, and hence a little less liable to errors from complications.

Mr. Hopkins: Q. You gave the weight of your leads, did you not?

A. Yes, that is stated—I don't know as I did either.

Mr. Adcock: You stated that it was the same weight—

A. They were within two pounds.

Mr. Hopkins: Q. Just what is the weight in pounds?

A. I do not have the memorandum of that here, unfortunately, but my recollection is it was 139 pounds. We started to get the 136 pounds and we came within about two pounds. We took it out of this report (indicating).

Mr. Adcock: Q. When you say "this report," you mean what?

A. Took it out of the report of the Chief of Engineers for 1900. On page 5341, report of the Chief of Engineers for 1900, the statement is made: "The range was much reduced

in the winter and spring of 1899, by the use of the 136 pound lead on the B meter instead of the standard 36 pound one." And elsewhere, the statement is made that a similar weight was used on the other meter. And it was this weight that we were endeavoring to approximate.

Mr. Hopkins: Q. Mr. Williams, will you produce the notes and the details of those tests for the examination of the Government Engineers in this case?

A. Certainly.

Q. Taking the winter, how much retardation of flow in the Chicago Drainage Canal would be due to floating ice?

A. Well, it is hard to say. The reduction of flow in the canal, comparing the winter and summer conditions, is somewhere around a thousand cubic feet a second, when they are attempting to flow around 7,000.

The winter conditions are such that it is not possible to draw the amount of water through the Power House that is required to take care of their lighting loads, and on many days they have to cut out lights. The capacity of the wheels there is considerably less than 10,000 cubic feet a second, so that the winter conditions are such that they certainly cannot draw 10,000 cubic feet a second through the canal. How much of it is due to floating ice—

Q. You mean through the canal or the power house?

A. I say through the wheels at the power house. The trouble of course is partly in the wheels and partly in the canal. It is hard to say how much is in one place and how much in the other.

Q. Do you think with the same opening at the power house then there is 14 to 15 per cent. difference between the summer flow and the winter flow?

A. No, that includes some change in lake elevations. That figure I just gave is based upon taking the actual record, four months in warm weather and four months in cold weather the amount of water that is discharged.

Q. Do you know whether there was an effort made to flow the same amount in those two four month periods?

A. There was an effort made to flow through the wheels a greater amount in the winter than there was in the summer, and they were unable to get it.

I have during the past month been engaged on an investigation of the conditions of the electrical development, and we discovered very early in the investigation that in the winter they

were not able to get the quantity of water through there that they do get in the summer.

Q. Just what natural conditions do you attribute that to?

A. That is attributed to several things.

Of course in the first place there is the changing viscosity of the water due to the lowering of the temperature.

In the second place there is the effect of floating ice, which not only has an effect by rubbing along the banks, but it also has an effect in rubbing on itself. It is somewhat similar to the condition that you get when you try to transport sand in water. If you transport sand in water it requires a materially larger head to deliver a given quantity of water and sand. The presence of the sand in the water increases the resistance to the flow.

I believe that the presence of ice in the upper layers of the stream increases the resistance of flow there in a somewhat similar manner. And I may say that the coarser sands, as I recall the experiments, cause greater disturbance than the finer ones.

In addition to that, speaking of the winter condition, the lake is always lower in the winter than it is during—the general level of the lake is lower during the winter than during the summer and consequently there is not the head available to draw water through the canal, and as a result the flow at the Power House is deficient in the winter time, or is reduced in the winter time.

Q. That is on the assumption of putting everything through the power plant and not using the waste gates?

A. That is based upon observations in which the bulk of the water was used through the turbine. It is not however based solely upon that observation, because I have made experiments on a comparatively large scale, in which the effect of the viscosity of the water came out very clearly.

In this case, we had in two sets of tests water at about 70 degrees temperature, and in the other water between 33 and 40, with no floating ice. The water was passed through turbine wheels and over a weir, and the result indicated as I testified in my direct testimony, the effect of the change of temperature there of the water in the experiments ranges between 2.7 and 3.1 per cent.

Q. Where was that test made?

A. Made at Holyoke, at the testing flume.

Q. Is that the one through sand or something of that kind?

A. No sand.

Q. Would the viscosity of the water in the Drainage Canal

due to change of temperature from 70 degrees to say 33 degrees be any different or greater than it would be in the canal at Cornell or in the Niagara River?

A. I think the effect would be somewhat greater on the Sanitary Canal, on account of the greater percentage of foreign matter present in the water. If you increase the viscosity of the water, the presence of foreign matter would have a greater effect than it would in the less viscous fluid; and as the Niagara River is considerably clearer, freer from foreign matter than the Drainage Canal, I would expect the effect of viscosity due to change of temperature would be greater in the canal than in the river.

Q. Would that be as much as 100 or 150 per cent.?

A. I could conceive it might make 100 per cent. difference in the effect due to viscosity, or due to change of viscosity I mean.

Q. Is that your opinion as well as your conception?

A. I think it is quite possible it could. In fact I would not be surprised if that were found to be the case.

Q. I am speaking only of the viscosity of the water?

A. That is what I understood you to mean, the effect of the change of viscosity between hot and cold weather I would expect might be 100 per cent. greater in the canal than it would be in the rivers.

Q. Because of the nature of the water?

A. Because of the nature of the water.

Q. What per cent. would you give to the floating ice?

A. Well, that is a very hard thing to determine. I do not know of any experiments that really give us a basis upon which to make an accurate determination.

Q. Do you think taking four months in the winter the conditions as they are in the Chicago Drainage Canal that the floating ice for all that time would make a difference of five per cent.?

A. You mean in the capacity of discharge?

Q. Yes?

A. Well, it is hard to say. The effect of course of the floating ice only reaches through a part of the canal, on account probably of the chemical action taking place in the water. The ice disappears before it goes a great ways down the river or down the canal. That makes it rather difficult to base conclusions on any information that I have. And I do not know of any definite experiments to show what the effect on discharge is of the presence of floating ice, except that we know very well that it does reduce the discharge.

Q. As a matter of fact, does not floating ice go just as fast or faster than the water itself?

A. If it goes faster, it must receive the energy from somewhere, and the entire energy of flow is due to the difference of elevation in the—

Q. Isn't the energy in the fall of the ice?

A. In the fall of the stream.

Q. Isn't it a matter of fact that a float travels a little faster than the water in which it is traveling?

A. That is a matter that has been discussed upon theoretical grounds, and Mr. James B. Francis went into an analysis of it, and as I remember his decimal is out in the third place. That is if any correction was to be made it was—

Q. That does not indicate any retardation, does it?

Mr. Adcock: Wait a minute; he had not finished his answer.

A. It was so small that Mr. Francis decided that the float went at the same velocity as the water, and that appears to be borne out well by comparisons in measurements of discharge of floats with weirs where the two have checked within ½ of 1 per cent., so that I cannot conceive that there is any likelihood that the ice travels faster than the water surrounding it.

In fact, I am quite well aware that in many cases it does not travel so fast. I never have seen ice traveling through the water where it showed any indication of moving faster than the water in its vicinity, unless somebody was pushing it with a pike pole.

Q. Under what circumstances did you see it traveling slower?

A. When it jams on the sides, or is retarded by rubbing against some other cake of ice that is moving at a less velocity. Where you have a large cake of ice floating down, it necessarily assumes a velocity representing the mean of the current in which it is traveling. A small cake coming along moving in a swifter current will impinge upon it and be retarded by it. Such occurrences are very frequent when there is no jamming against the sides.

Q. How much of the time in the course of the winter is there floating ice in the canal?

A. I am not able to say.

Q. Do you know how much of the time Lake Michigan is frozen over at this end?

A. I think I can furnish you with that information.

The United States Deep Waterways Commission reports in

a table on page 196 the average dates of opening and closing of navigation at Chicago, Illinois, are: For closing, January 7; for opening, February 27, and that the information is based upon ice.

Q. When was that report?

A. The report is dated in 1896, and states further that the average dates of closing from the winter of 1876-77, to the winter of 1895-96, inclusive, at Chicago—

Mr. Adcock: Is that on account of ice?

A. That is on account of ice, was January 10, and the average date of opening was February 24, giving a period of days when the harbor is closed of 45.

Mr. Hopkins: Q. Do you know how much of that time, or does the report show how much of that time it is actually blockaded by ice?

A. It does not.

Q. Also whether or not the ice is in the lake or in the river?

A. It does not say anything about whether it is in the river or not.

I will tell you in just a moment, possibly, something with relation to this. (Referring to report mentioned.)

The statement is made on page 194—the larger proportion of the tables is actual ice record; some of the remainder are first and last vessels, and others official opening and closing. The record for Chicago is marked "ice." The records for some other places are, some of them marked first and last vessel; some of them "official." The conclusion is that this refers to the actual ice conditions.

Q. That is, that is the average of the beginning of some ice, and the average when the ice is out?

A. That is the average time that the port is closed on account of ice.

Q. But does not show whether ice is in there all the time?

A. It is not clear whether it extends beyond that, at certain times.

Q. It does not show where the ice is. I believe you have already stated.

A. Well, it was where it closed the port, evidently.

Q. Might it not be to some extent because of the difficulty of getting in and out of the port in the lake?

A. I don't quite get that question.

Q. (Question read.)

Mr. Adcock: That is some ice or what caused the difficulty?

Mr. Hopkins: Yes, ice. It does not mean that the river itself was frozen all that time?

A. I do not understand so. In fact at that time, or during a considerable portion of that time—yes, all of it, the river was discharging sewage in the lake. I think under those conditions there was very little ice in the river. And that also had a tendency to keep the lake open to a greater extent.

Q. With a constant current flowing now and carrying sewage, which is supposed to cause the water to be a little warmer than water without sewage, there is hardly so much ice in the river as there was then, is there?

A. There is certainly more ice in the river now than then because there could have been no ice in the river that did not form in the river except at the times when the Bridgeport pumping station was delivering more water than came from the sewers of Chicago. Now, there is ice in the river coming from the lake. The fact that there is a large body of water being drawn into the river tends to draw into it and clog up its mouth with the floating ice in the vicintity, or within the reach of the current.

Q. Now will you state what effect you think it has on the total volume then, that floating ice, percentage?

A. I have said that I have no data on which I can base that statement.

Q. Give us some outside limits, 10 per cent., 5 per cent., 2 per cent.?

A. I gave in my direct testimony a statement of the effects of the various causes of retardation of flow accompanying the presence of ice. My range I believe was from 3 to 10 per cent. I am not prepared to divide that into just how much is in one thing and how much is in the other. I think those limits are conservative.

Q. You think it might run as high as 10 per cent.?

A. I think the effect of the cold water, including the ice, might run as high as 10 per cent.

Q. Now it is true that at the Power House and Controlling Works, you can make an opening to take care of the same amount in winter that you do ordinarily in summer by increasing the openings to take care of that, say up to 10,000 cubic feet a second?

A. I doubt if you can make an opening at the Power House and Controlling Works that would produce a flow of 10,000 cubic feet through the canal in the winter. That is through the entire length including the river.

Mr. Adcock: Q. That is in its present condition?

A. That is in its present condition.

Mr. Hopkins: Q. If you were given permission, if the Sanitary District were given permission to take 10,000 cubic feet a second, they could not do it through the winter without an enlargement of the canal?

A. I think they would have to enlarge portions of the river in order to get that quantity of water through, at the present time.

Q. You said something about a fixed coefficient in the measurement of the Niagara River as tending to decrease the increment. You think a variable coefficient would have gotten better results?

A. I think a coefficient that coincided with the facts would have gotten better results than one which was simply the average of a large number of observations under different conditions.

Q. Suppose that the coefficient corresponded with the facts at the time the discharge measurements were made and the increment derived from that checked with the increment obtained by a fixed coefficient?

A. I should want to know how they were derived. I should want to know the number of observations upon which they were based, what degree of accuracy could be claimed or established for the observations?

Q. Did you know that in the coefficient work at the Open Section, Niagara River, that it was the fact that the coefficients were determined according to stage?

A. I do not think that that has been brought out in the testimony in this case so far.

Q. Referring to report of the Chief of Engineers for 1900, Appendix III, page 5347, are you familiar with the table of mean velocity coefficients at the Open Section as they appear on that page?

A. Somewhat.

Q. Did you ever yourself make any tests as between what we have called a fixed coefficient and a variable coefficient according to the stage, as to which will give you better results?

A. I have made tests which showed that it was not the same.

Q. What tests have you made?

A. Current meter tests.

Q. Where, under what circumstances?

A. In rivers, in the canal at Cornell, by comparing the discharges at different depths in the work of the Lake Survey.

Q. What was your range of depth?

A. We got ranges of depth from about 20 to 50 feet.

Q. You found you could not apply a coefficient determined at a 20 foot depth to a coefficient determined at 50 foot depth?

A. The two were not the same, so far as the records go.

Q. Did you ever get coefficient work out by taking into consideration all of those depths as the fixed coefficient?

A. Well, the whole point is that for the deeper depths the coefficient is greater than it is for the shallower ones all the way through, when your index point is near the top of your stream. If you go down to half depth, then I am not so sure what the results show.

Q. Take the condition at the Niagara River where the range of stage is not so great as from 20 to 50 feet, but is 4 feet, and competent engineers should make tests and determinations as to whether there would be any effect or differnce between variable coefficients and fixed coefficients, and should come to the conclusion that there was no appreciable difference, much less than 1 per cent., would that have any effect on your opinion in that regard?

A. I should want to know who the competent engineers were and what investigations they made. I have also pointed out in my testimony that the difference would have to be considerably less than 1 per cent. Did I understand you to say 1 per cent.?

Q. Yes, that is what I said. I mean by less than 1 per cent., 1 per cent. on the increment.

A. I do not think any observations we have are within such a limit as to permit us to talk of increments within 1 per cent., either for comparison or any other purpose?

Q. Have you got your Exihibit 40?

A. Which exhibit is that, Mr. Hopkins?

Q. That is Stewart's cable inclinations?

A. There is a tracing of it that I made. (Indicating same.)

Q. In giving your conclusions as to how far the meter must have been down stream, were you basing that upon this exhibit as to the point at which the cable was held upstream by some other force?

A. Not at all. No, I understand Mr. Shenehon's device to be different from the one used by Mr. Stewart.

Q. What did you understand his method to be?

A. I understood it to be as shown here. I understand the

position of the weight above the water surface was maintained practically constant.

Q. So that the drift downstream would be from the water surface rather than from the bridge?

A. It would be from the position of the weight.

Q. That is close to the water surface?

A. Yes. In our computations, I think we assumed that that was about six inches above the water surface. I do not know whether we were correct in that assumption.

Q. Then did you understand that the sleeve weights which were used by Mr. Stewart were not used by Mr. Shenehon?

A. That was my understanding. Mr. Shenehon said so distinctly in his testimony.

Q. Do you think that would make any difference?

A. As to whether you use sleeve weights or put one big weight at the bottom, I think it would make a difference, yes.

Q. Did you take that into consideration?

A. We estimated the position of Mr. Shenehon's meter with the conditions as we understood them from Mr. Shenehon's testimony, which were, that the A meter was supported on a ⅜ cable, which was not drawn upstream, but was allowed to take the position which it naturally took as it swung from the bridge. That the B meter was attached to a quarter inch cable, and was held in the supposed plane of the meter support by drawing upstream on a device which we understood to be similar to the one which is shown upon this chart which is now before me, which is marked: "Lake level Niagara River, Analysis of Position of Meter 2B, with 120 pound lead, at Station 4 6/12 International Bridge Section, and comparison with meter A number 12, using sleeve weights. Scale ¼ inch equals 5 feet. Francis C. Shenehon, United States Assistant Engineer, Number 33 Austin street, Buffalo, February 13, 1899."

Q. In getting your result, did you use the same method as that used by Mr. Shenehon as shown on the chart that you just referred to, taking into consideration the greater pressure according to your tests at the naval tank, or did you use the curve as shown on your Exhibit 40?

A. We used the information obtained from the tests in this naval tank, paid no attention to Exhibit 40.

Q. Suppose on the B meter, the block had been drawn up stream eight feet above the section, what is your conclusion as to how fr[illegible] down stream the meter would be at 50 feet depth with a surface velocity of 6 feet per second?

A. Answering your question as asked, where the depth

was greater than 40 feet, the pressure on the meter was reduced to a 6 foot velocity, and where it was greater than 50 feet, the portion below 40, was assumed to be at 5 feet a second, so that this is giving you the advantage of that velocity at 5 feet a second between 40 and 50 feet depth over what you started out to assume. In these computations we assumed a velocity of 6½ feet as covering that position of the meter down to 40 feet, but when we got down to 40 feet we assumed the velocity of the current throughout the whole was 6 feet, and when we got down below 40, if the cable was below 40, we used 5 feet, taking into consideration the change of velocity in the vertical, as you go down.

Q. Is that your opinion as to what is the velocity down there?

A. That corresponds fairly with the velocity curves that appear for that section as I recall them.

Q. How far down stream would the meter be at that depth?

A. If you had drawn it up eight feet?

Mr. Adcock: At the water surface?

Mr. Hopkins: Substantially at the water surface?

A. Now do you mean eight feet above the vertical, or eight feet above the position at which it would naturally be in the water?

Q. No, eight feet above the bridge chord, eight feet up stream from the bridge chord?

A. If it were drawn up eight feet above the bridge chord, assuming that the meter were 50 feet below the surface of the water and it were drawn up eight feet above the plane of the bridge chord, the meter would then be five feet down stream from the plane of the bridge chord.

Q. You make the down stream drift under these circumstances about 13 feet?

A. Yes. It would be really a little more than five feet, because I am figuring from the water surface. Of course there would be a little further drift due to the length of cable between the weight and the water.

Q. On the plot to which you have just referred showing curves by Mr. Shenehon, doesn't he get a result of 12.5 feet?

A. His testimony was that he corrected for a drift of 12.5 feet.

Q. Then as far as the B meter is concerned, there was no great error in Mr. Shenehon's work?

A. Yes, because with the device as shown, keeping the

weight near the water, he could not have pulled it up eight feet from the plane of the bridge chord.

Q. You mean—

A. I will say that it is my opinion that he could not.

Q. You mean on account of the 80 pound weight that was used?

A. Yes.

Q. Well by adding sleeve weights, could it not be held at the water surface eight feet above the section?

A. By adding them where?

Q. To the 80 pound weight?

A. If you have added enough probably it could.

Q. Did you notice on this chart that you read that by adding to the 80 pound weight 2 or 3 sleeve weights, the meter can be held vertically in the bridge chord?

A. Yes, but it was the testimony of Mr. Shenehon that the weight used was 80 pounds. What he could have done and what he testified that he did do are necessarily two different things. I am basing my judgment on what he testified he did do. We asked him quite particularly about that point as we did not wish to be led into error.

Q. In estimating the error which in your opinion came from the location of the meter due to the increased cross-section, did you simply give the volume of discharge in direct proportion to the increased size of the cross-section? In other words if there were a 10 per cent. greater cross-section, there would be a 10 per cent. greater discharge?

A. The theory upon which we proceeded was that if a mean velocity was established for a cross-section of 100 per cent., and that velocity should have been applied to a cross-section of 110 per cent., the discharge would necessarily be increased 10 per cent.

Q. What is the condition of the water just below the bridge piers?

A. Considerably disturbed.

Q. As far as flowing down stream, though, is concerned, it is practically dead, is it not?

A. I think not. Of course there is an eddy there around the heel of the pier, very decided one, and the water closes in around that eddy pretty promptly. The experiments on the flow of water under conditions of that kind show that the velocity checks very promptly after passing the lower end of such an obstruction.

Q. Do you know what the shape of that pier is below the—

A. Yes, I think so.

Q. What is it?

A. I know approximately; the lower end, it is of rectangular section, lower half of the pier, plan, I mean.

Q. Do you know that it rests on a caisson?

A. I understand that it does.

Q. Do you know how far below the pier the caisson is?

A. We endeavored to find that out, and nobody seemed to be able to establish that fact for us, so that I was compelled to base my conclusions upon such information as I could get from outside sources.

Q. You never have made any soundings there, anything of that kind?

A. No, we had the Government soundings, which did not appear to be particularly definite in regard to the condition next to the piers. I mean we had the plotting from the Government soundings. We did not have their soundings.

Q. Do you know whether or not there is any stone below the piers of the caisson which would tend to protect it, make it more stable?

A. I understand that there is.

Q. With all that, then, would there not be an area just below those piers of dead water, or water in which the volume is much reduced in flow?

A. You mean velocity?

Q. Velocity?

A. The velocity immediately behind and below the piers would be considerably less than it is out in the middle of the section. At the same time, as I have said, as soon as that water passes those piers it begins to be retarded and checks very materially.

I can point out another illustration of that. The explanation that has been given as to the St. Lawrence River gaging has been that the reason there is such a difference in the results is on account of a change in velocity in the section, which must have occurred within a very few feet, undoubtedly less than we are considering here; and that seems to be the only explanation that has been given by which anybody is able to explain the difference between the later and the former gagings.

Now if such a condition could occur at the Three Point Section on the St. Lawrence to the extent that it is alleged to have occurred there, or appears to have occurred there, accepting that as the explanation for the difference in discharge shown by the different gagings, it would mean that there must be a

very much greater effect where the change is as abrupt as it is at the International Bridge.

Q. Do you accept that explanation of the St. Lawrence River yourself, or are you simply relying upon what other people state?

A. I know nothing about it.

Q. What is your opinion in regard to it?

A. I should want considerably more information than I have before I express an opinion.

Q. Then arguing from that to the International Bridge, you are not expressing your own opinion as to the actual fact at the International Bridge, but that is based upon the assumptions of other people which you do not accept of?

A. In speaking of the International Bridge, I am basing my opinion on my own observations of the effects of such disturbances upon flowing water, and just as I stated that the velocity is checked very appreciably where it passes by the edge of a square contraction of a submerged orifice.

I simply conceive of the St. Lawrence as a corroboration of that condition, if we are to accept as correct the judgment of the gentlemen in the Lake Survey who have given more study and brought more experience to the consideration of the question.

Q. You say "if we accept it." Do you accept it? In other words do you regard it as a corroboration?

A. Oh, I would take it simply for what it is worth.

Q. What is it worth?

A. A number of experts, who are supposed to be the most expert in the measuring of rivers, those who have given years of study to it, who have been brought up in it and have done practically all the good work that ever was done give that as an explanation.

Those of us who have studied water under other conditions where we have been able to weigh the volumes that were passing, where we have been able to measure it over weirs, measure with different devices, floats, pitot tubes, current meters and so on, would probably want more evidence on the subject—would certainly want more evidence on the subject than has been presented in this case.

But the fact remains that there is a discrepancy between two measurements alleged to have been made, two sets of measurements alleged to have been made at the same place by equally competent observers, and in going through the various causes for the difference, it has been clearly stated

that one thing and another thing failed to explain it, and the only explanation that has been offered is this one of a change of velocity through the section and that in one case the meter had drifted into a different position from that which it occupied in another.

Mr. Adcock: Q. That was Mr. Richmond who made that statement.

A. That was Mr. Richmond's explanation, and it was repeated by Mr. Shenehon.

Mr. Hopkins: Q. When you say "we should like more information," you mean you personally?

A. I mean myself personally. I used the editorial "we" in this case.

Q. Then do you not consider that these engineers of whom you have just spoken are entitled to some consideration for their work in the Niagara River?

A. I think they are. I think they have done very well with a difficult problem. I have said that many times.

Q. That question of the difficulty there and the change of the size of the section, or the place of the meter during the measurement, does not occur at the Open Section, does it?

A. No, I would not expect a variation of position of the meter at the Open Section would have any marked effect.

Q. Do you think it had any effect in what we call the Split Section?

A. I should not think so. Still I might say this in regard to the Open Section, that if it had an effect in the St. Lawrence, I would think it might have an effect in the Open Section.

Q. But you do not attempt to say one way or the other whether it had any effect at the St. Lawrence?

A. I do not—well, I will say I think it might have had some effect.

Q. So that you are not giving your own personal opinion, but simply arguing the case?

A. I am simply comparing such information as I have.

Mr. Adcock: Q. And giving your reasons?

A. Giving my reasons.

Q. As an expert?

A. For the notions and views that I hold, the opinions that I have. I think all the testimony we give in these scientific matters is based upon something outside of the specific matter which is included in the question. We base our judgments upon what we have done; what we know other people

have done; what we have thought about what we have done; what other people have thought about what we have done and what other people have thought about what they have done and what we have thought about what other people have done. We put this all together in a sort of melting pot.

Mr. Hopkins: Q. Now Mr. Williams, if the B meter was not in fact below the piers and the caisson and you determine your coefficient at your index point, does it make any difference whether the index point is below the bridge piers or not?

A. It would not, if you did not correct the indication of the B meter to correspond with that of the A meter at the index point, which is my understanding of what was done.

Q. But if that correction was not made, then it would not make any difference?

A. No, on the assumption that the A meter was between the piers.

Q. The B meter was between the piers?

A. The B meter was at the piers, if the velocities were not corrected to the velocity at the index point as indicated by the A meter, then of course your coefficient would be entirely correct within the degree of precision we are considering the observations in general. There would be no special error introduced due to the fact that the index point was not between the piers.

Q. Referring to your answer in regard to the pressure on 1/4 inch and 3/8 inch cable at velocities 5, 6 and 7, does it not show that the resistance on the 1/4 inch cable is 2/3 of that of the 3/8 inch cable. Take the 5-foot velocity.

A. Starting at the 7-foot and running back, the observed resistance of the 3/8 cable at a 7-foot velocity is 19.2. Subtracting 1/3 from it gives 12.8 pounds for a 1/4 inch cable, and the observation was 13.3.

Q. What percentage of difference?

A. About four per cent.

Q. Then the others?

A. At 6 foot velocity the observed resistance of the 3/8 cable is 15 pounds. Subtracting 1/3 gives 10 pounds as the resistance on the 1/4 inch cable, and the observed resistance is 10.3 pounds.

Q. About 3 per cent.?

A. That is about 3 per cent. For the 5-foot velocity, the resistance of the 3/8 cable is 11.2 pounds. Subtracting 1/3 gives 7.47 or 7-1/2, which latter figure coincides with the experimental result for the 1/4 inch cable.

Q. Now taking into consideration the possible errors of observation, do you think that it is poor physics to make an estimate of 2/3?

A. Let me see what you are referring to there.

Q. I understood you to say in your direct examination that estimating a 1/4 inch cable with that weight would give 2/3 resistance of the 3/8 inch cable did not conform to your idea of physics?

A. Let me see if I said just that.

Q. Do I quote you correctly?

A. I am a little in doubt as to just what I did say. I do not think I made the statement that you attribute to me.

Q. The statement was this, (at page 3359 of the typewritten record, printed record, 3526). "Upon the conclusion of Mr. Shenehon's cross-examination, I was impressed with the fact that the conclusions elicited in the cross-examination were not strictly in accordance with the laws of physics as I understood them, and I immediately arranged to have a series of experiments made in the naval tank of the University of Michigan, and so on?"

A. There was nothing said about 3/8 and 1/4 inch cable.

Q. Just what were you referring to there, Mr. Williams?

A. I was referring to the computed drift of the meter in that and in part to the assumption that has been suggested that the resistance of a 1/4 inch cable would be 2/3 that of a 3/8 inch.

Q. On page 3362, you say in your opinion the 1/4 inch cable would drift further down than the 3/8 cable. That would not be so if you put the same weight, say of 140 pounds, on each of them, would it?

A. Where do I say that?

Q. Page 3362, in the last complete paragraph, last sentence in it?

A. That says nothing about a weight on the cable. That statement is entirely correct as made here.

Mr. Hopkins: Read my question.

(Question read.)

A. No, it would not. You may strike out my previous answer; I did not understand the question.

Q. And the question of a cable drifting down-stream without weights on it was not involved in these experiments in the Niagara River, was it?

A. It is to a certain extent. It involves the resistance of the cable itself; in arriving at a theoretical discussion of this thing,

without basing it on experiments, you have to consider the weight of the cable.

Q. But with that size cable and the size weights that were used, the weight of the cable was not a very important factor; that is the difference in the weight of the cable between the 1/4 inch and the 3/8 inch?

A. It is quite an important factor as shown by the difference in amounts of drift that we get with the cables as compared with those which hitherto have been assumed in the placing of the meters at the bridge.

Q. But you get a greater amount of drift on the 3/8 cable with the weight on it, than you do on the 1/4 inch with the weight do you not?

A. Yes, I think so.

Q. And your tests check Mr. Shenehon's rather closely as to the amount of drift from the surface of the water?

A. Not according to his testimony. He testified that his drift was 12-1/2 feet and we made it 26.

Q. 26 feet from where?

A. Wait a minute, let us get that testimony straight on that, because as I understood the testimony—

Q. When the cable is held at the surface of the water, and taking a depth of 50 feet, how far down stream below that point at the surface where the cable is held does the meter drift?

A. About 13 feet.

Q. When you gave a drift of 26 feet, what do you mean by that, exactly?

A. I mean the drift of the meter when it was not restrained.

Q. That is from the top of the bridge?

A. Yes.

Q. How high above the water is that?

A. If you figure from the chord, it would be—let us assume it from the support of the meter; it is a distance of about 29 feet, leaving out the effect of that drift.

Q. You consider, do you, that a test in deeper water under the actual conditions, everything else being equal, would be better than the test as made in the naval tank?

A. I would consider that a test with a dynamometer under the actual conditions of flowing water would be more reliable than the test of dragging the meter through still water, being the same proposition of course that we have in rating the meter.

Q. Also would not the greater depth in the one case give you a little better results because of the fact that any error in observation would be accentuated to take a small range and apply it to a bigger one?

A. You mean now as to the resistance of the meter or the resistance of the cable?

Q. Using six feet of cable rather than ten feet or twenty?

A. I would prefer to use ten or twenty if I could measure the pull on it with the same degree of accuracy that I could measure the 6-foot cable.

Q. You did not know as a matter of fact did you that Mr. Shenehon used a dynamometer at the International Bridge of the Niagara River to determine this question?

A. I did not. There is nothing in his testimony to indicate it.

Mr. Hopkins: That is all.

Mr. Adcock: I offer in evidence letter from B. A. Eckhart, President of the Sanitary District of Chicago to Hon. Daniel S. Lamont, Secretary of War, dated June 16, 1896, with reference to the improvement of the Chicago River.

Also a letter from Major W. L. Marshall, Corps Engineer, to Brig. Gen. William P. Craighill, Chief of Engineers United States Army, dated Chicago, June 24, 1896.

A letter or permit addressed to B. A. Eckhart, President Sanitary District of Chicago, signed by Joseph B. Doe, Acting Secretary of War, dated July 3, 1896.

Also a letter addressed to Hon. Russell A. Alger, Secretary of War, signed by Thomas Kelly, President of the Sanitary District of Chicago, dated October 28, 1897.

Also a paper entitled "First Indorsement" to the above mentioned letter; United States Engineer Office, Chicago, Ill., October 29, 1897. Signed W. L. Marshall, Major Corps Engineers.

Permit dated November 16, 1897, to the Sanitary District of Chicago, signed R. A. Alger, Secretary of War.

A letter dated November 12, 1898, addressed to the Honorable Russell A. Alger, Secretary of War, signed by William Boldenweck, President.

Also the notation at the bottom of the letter as follows: "Through Maj. W. L. Marshall, Corps of Engineers, United States Army, 1637 Indiana avenue, Chicago, Ill."

Also a letter entitled "First Indorsement, U. S. Engineer's Office, Chicago, Illinois, November 15, 1898," and signed W. L. Marshall, Major Corps of Engineers.

Also a permit dated November 30, 1898; to the Sanitary District of Chicago, signed R. A. Alger, Secretary of War.

Letter dated December 16, 1898, addressed to the Hon. Russell A. Alger, Secretary of War, signed William Boldenweck, President Sanitary District of Chicago.

First indorsement to that letter entitled "First Indorsement United States Engineer's Office, Chicago, Illinois, December 21, 1898, signed W. L. Marshall, Maj. Corps Engineers."

Permit dated January 13, 1899, to the Sanitary District of Chicago, signed R. A. Alger, Secretary of War.

Letter dated April 26, 1899, from William Boldenweck, President Sanitary District of Chicago, addressed to Hon. Russell A. Alger, Secretary of War. Also paper entitled "First Indorsement United States Engineer Office, Chicago, Ill., May 1, 1899," signed W. L. Marshall, Maj. Corps of Engineers.

Permit dated May 12, 1899, to the Sanitary District of Chicago, signed by G. D. Meiklejohn, Acting Secretary of War.

Letter from William Boldenweck, President Sanitary District of Chicago to the Hon. Russell A. Alger, Secretary of War, dated February 27, 1899.

Paper entitled "First Indorsement U. S. Engineer Office, Chicago, Ill., March 1, 1899," signed W. L. Marshall, Maj. Corps of Engineers.

A permit dated March 10, 1899, to the Sanitary District of Chicago signed by R. A. Alger, Secretary of War.

A letter dated April 24, 1899, to Brig. Gen. John M. Wilson, Chief of Engineers, U. S. A., signed by W. L. Marshall, Maj. Corps of Engineers, U. S. A.

It is understood that any objection as to materiality and relevancy may be raised at the hearing.

Mr. Hopkins: Q. I also reserve objection to the competency especially as to those letters written by the Sanitary District of Chicago or any of its officers or officials, on the ground that they are self serving; I object also to letters of various engineering officers of the United States Army as being incompetent. There is no objection on the ground that they are not true copies of letters that were in fact written.

Mr. Adcock: No objection on account of their not being the best evidence.

Mr. Hopkins: No, no objection as between the copy and the original. I do object to their competency otherwise as

well as on the ground of materiality, as stated by Mr. Adcock.

Mr. Adcock: These letters to which I have just referred are as follows:

"The Sanitary District of Chicago.
Chicago, June 16, 1896.

To the Honorable Daniel S. Lamont,
Secretary of War,
Washington, D. C.

Dear Sir:

The work of the Sanitary District of Chicago has progressed so far that it is now necessary for us to enter upon that which must be done in the Chicago River to make available the artificial channel which we have under construction from Robey street, Chicago, to Lockport in Will County, twenty-eight miles distant.

Our connection with Lake Michigan must be through the Chicago River with the West Fork of the South Branch of which we make a junction at Robey street. We send herewith a map showing in a general way our plans for improving the Chicago River by widening and deepening at the points indicated thereon by red hatchings and by figures which refer to explanations given in the legend on the map. It is desired to so correct and regularize the cross section of the river as to secure a flowage capacity of 300,000 cubic feet per minute with a velocity of 1-1/4 miles per hour. The cross section necessary to accomplish this can be obtained throughout the greater part of the distance between Monroe street and Robey street by dredging the river to a depth of 20 feet at mid-stream with 12 feet at dock lines, and a uniform slope away from the docks of 1 foot in 5 so that the full depth would be reached 40 feet from the dock lines; but there are places so narrow that this cross section can only be obtained by widening the river; and again the depth to be obtained in the vicinity of Van Buren street is limited by the height of the crown of the tunnel. To obviate this difficulty it is proposed to secure the requisite cross section by constructing a by-pass to the west of the bridges at Adams, Jackson and Van Buren streets as indicated. We ask your permission to proceed with the work upon the lines indicated and so far as is consistent with propriety the co-operation of the United States Engineering Department.

Awaiting your favorable reply and holding ourselves ready

to respond to any call from you for fuller information as to our plans, I am,

Yours respectfully,

B. A. ECKHART,

President."

"Subject: Application of Trustees Sanitary District, Chicago.

"UNITED STATES ENGINEER OFFICE.
1537 Indiana avenue, P. O. Drawer 132.
Chicago, Ill., June 24, 1896.

Brig. Gen. Wm. P. Craighill,
Chief of Engineers, U. S. A.,
Washington, D. C.

General:

I have the honor to report upon the application of Mr. B. A. Eckhart, President Board of Trustees, Sanitary District of Chicago, for the authority of the Secretary of War to make certain changes in the capacity of the channel of the Chicago River for drainage purposes.

As far as the work itself is concerned there can be no objection to it, as in every case the navigable channel of Chicago River will be improved, and at this stage I am unable to do otherwise than to recommend the granting of the authority sought.

The question that must come up later for the action of the War Department, to-wit: Whether the improved channel of Chicago River will be sufficient to carry 300,000 cubic feet of water per minute without lessening or destroying the navigability of Chicago River, or whether the City of Chicago will be allowed by the United States and Great Britian to take any water at all from the Great Lakes, with the inevitable result of lowering their levels is not now under investigation, and is one that will not probably be settled or decided by executive officers. It is or may rather be considered an international question.

For the present I have to respectfully recommend that the necessary authority be granted as requested for the general, under the conditions:

(1) That while the general plan is approved, the Sanitary District of Chicago must furnish plans in triplicate on an enlarged scale showing each proposed new bridge, each by-pass and each new dock or wharf, proposed to be built, in order that the Secretary of War, under the law, may act intelligently in each case.

(2) That this authority shall not be interpreted as approval of the plans of the Sanitary District of Chicago to introduce a current into Chicago River. This latter proposition must hereafter be submitted for consideration.

(3) That it will not cover obstructions to navigation by reason of this work while in progress, or when completed.

(4) That the United States shall not be put to expense by reason of this work.

(5) That this authority will expire by limitation in two years from date, unless extended.

Very respectfully,

Your obedient servant,

W. L. MARSHALL,

Maj. Corps of Engineers.

Subject: Improvement of Chicago River.

WAR DEPARTMENT.

Washington.

July 3, 1896.

Sir:

I have the honor to acknowledge receipt of your letter of the 16th ultimo, requesting permission to make certain changes in the capacity of the channel of the Chicago River, for drainage purposes, at points indicated on the map accompanying the application, and in reply beg to say that upon investigation it is found that the permission requested can be granted upon the following conditions:

1. That while the general plan is approved, the Sanitary District of Chicago must furnish plans in triplicate on an enlarged scale showing each proposed new bridge, each by-pass, and each new dock or wharf, proposed to be built, in order that the Secretary of War may act intelligently in each case.

2. That the authority shall not be interpreted as approval of the plans of the Sanitary District of Chicago to introduce a current into Chicago River. This latter proposition must be hereafter submitted for consideration.

3. That it will not cover obstructions to navigation, by reason of this work while in progress, or when completed.

4. That the United States shall not be put to expense by reason of this work.

5. That this authority will expire by limitation in two years from date unless extended.

Very respectfully,

JOSEPH B. DOE,

Acting Secretary of War.

B. A. Eckhart, Esq.,
President The Sanitary District of Chicago,
Rialto Building,
Chicago, Ill.

THE SANITARY DISTR'CT OF CHICAGO.
Chicago, October 28, 1897.

To the Hon. Russell A. Alger,
Secretary of War,
Washington, D. C.

Sir:

I have the honor of transmitting to you through Maj. W. L. Marshall, Corps U. S. Engineers, plats showing the proposed widening of the Chicago River between Quincy and Harrison streets, to conform to the plans of this District for securing an adequate flow of water through the said stream. Our general plans have been heretofore submitted to the War Department and in the communication under date of July 3rd, 1896, signed by the then acting Secretary of War, Joseph B. Doe, have received a qualified approval subject to the general requirement that plans for each separate division of the work shall be submitted for specific approval. We respectfully ask your approval of the plans now transmitted.

Very respectfully,
THOMAS KELLY,
President.

1st Indorsement,

U. S. Engineer Office,
Chicago, Ills., October 29, 1897.

Respectfully forwarded to the Chief of Engineers U. S. A.

The works indicated are by-passes and docks, indicated on the general plans conditionally approved by the Acting Secretary of War, July 3rd, 1896. (E. D. File No. 15715/5).

As these works make possible a material improvement in the capacity of Chicago River for navigation in the vicinity of Adams and Van Buren streets, I respectfully recommend that the necessary authority to do the work be granted by the Secretary of War, subject to all the conditions attached to the original authority dated July 3, 1896.

W. L. MARSHALL,
Maj. Corps Engrs.

Form No. 5.

Whereas, by Section 3 of the Act of Congress, approved July 13, 1892, entitled "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors and for other purposes," it is provided that, without the premission of the Secretary of War, it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty or structure of any kind outside established harbor lines or where no harbor lines are or may be established in any port, homestead, haven, harbor, navigable river, or other waters of the United States, in such manner as shall obstruct or impair navigation, commerce, or anchorage of said waters; or to excavate or fill, or in any maner to alter or modify the course, location, condition, or capacity of any port, roadstead, haven, harbor of refuge, or inclosure within the limits of any breakwater of the channel of any navigable water of the United States, unless approved and authorized by the Secretary of War;

And whereas, the Sanitary District of Chicago has submitted to the Secretary of War for his approval the attached plans for the widening of the Chicago River between Quincy and Harrison streets of said city, by the construction of by-passes and docks;

Now, Therefore, This is to certify that the Secretary of War hereby approves and authorizes the work shown on said plans upon the following conditions:

1. That while the general plan is approved, the Sanitary District of Chicago must furnish plans in triplicate on an enlarged scale showing each proposed new bridge, each by-pass, and each new dock or wharf, proposed to be built, in order that the Secretary of War may act intelligently in each case.

2. That this authority shall not be interpreted as approval of the plans of the Sanitary District of Chicago to introduce a current into Chicago River. This latter proposition must be hereafter submitted for consideration.

3. That it will not cover obstructions to navigation, by reason of this work while in progress, or when completed.

4. That the United States shall not be put to expense by reason of this work.

5. That this authority shall expire by limitation in two years from date unless extended.

Witness my hand this 16th day of November, 1897, R. A. Alger, Secretary of War.

(War Office Seal.)

THE SANITARY DISTRICT OF CHICAGO.
Chicago, November 12, 1898.

Hon. Russell A. Alger,
Secretary of War,
(Washington, D. C.

Dear Sir:

We respectfully ask permission to construct a cofferdam around the east side of center pier of Adams street bridge in Chicago River, said cofferdam to extend 3 feet outside of protection of bridge and to be constructed of piles and timber to be filled with clay. We would also request permission to deposit clay outside of the cofferdam running north and south from center pier and extending into the bank. All material of cofferdam and all clay deposited to be removed at the expiration of four months, or sooner if in your judgment the demands of navigation require it.

Very respectfully submitted,
WILLIAM BOLDENWECK,
President.

Through Major W. L. Marshall,
Corps of Engineers U. S. A.,
1637 Indiana avenue,
Chicago, Ill.

1st Indorsement.

U. S. Engineers Office,
Chicago, Ill., November 15, 1898.

Respectfully forwarded to the Chief of Engineers, U. S. A.

This work is necessary to enable the trustees of the Sanitary District to avail themselves of the authority heretofore granted by the Secretary of War to construct its by-pass at Adams street, and in my opinion may be done without unreasonable obstruction to navigation. I therefore respectfully recommend that the authority asked for be granted by the Secretary of War under the following conditions, viz.:

1. That a practicable channel for the passage of commercial vessels at this point be maintained by the authorities of the Sanitary District during construction.

2. That all debris and material attendant upon this construction be removed from the channel prior to May 1st, 1899, at which date this authority to expire by limitation.

W. L. MARSHALL,
Maj. Corps of Engrs.

Form No. 5.

Whereas, by Section 3 of an Act of Congress approved July 13, 1892, entitled "An Act making appropriations for the construction, repair and preservation of certain public works on rivers and harbors, and for other purposes," it is provided that, without the permission of the Secretary of War, it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty or structure of any kind outside of established harbor lines, or where no harbor lines are or may be established, in any port, roadstead, haven, harbor, navigable river, or other waters of the United States, in such maner as shall obstruct or impair navigation, commerce or anchorage of said waters; or to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of any port, roadstead, haven, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless approved and authorized by the Secretary of War;

And whereas, the Board of Trustees of the Sanitary District of Chicago, Illinois, has applied to the Secretary of War for permission to construct a temporary cofferdam around the east side of the center pier of Adams street bridge in Chicago River, at Chicago, Illinois, as shown on the attached blue print, and to deposit clay outside of the cofferdam running north and south from center pier and extending into the bank;

Now, Therefore, This is to certify that the Secretary of War hereby gives to said Board of Trustees permission to construct a temporary cofferdam around the east side of the center pier of Adams street bridge in Chicago River, at said place, as shown on said blueprint; and to deposit clay outside the cofferdam running north and south from center pier and extending into the bank, upon the following conditions:

1. That a practical channel for the passage of commercial vessels at this point shall be maintained by said Board of Trustees during construction.

2. That all debris and material attendant upon this construction shall be removed from the channel prior to May 1, 1899, at which date this authority shall expire by limitation.

3. That the work herein permitted to be done shall be sub-

ject to the supervision and approval of the Engineer Officer of the United States Army in charge of the locality.

Witness my hand this 30th day of November, 1898.

R. A. ALGER,
Secretary of War.

(War Office Seal.)

THE SANITARY DISTRICT OF CHICAGO.
Chicago, December 16, 1898.

Hon. Russell A. Alger,
Secretary of War,
Washington, D. C.

Dear Sir:

In carrying out the plans of this District for work in the Chicago River we have arranged to remove the bridges now existing at the Taylor street crossing and at the crossing of the Chicago Terminal Transfer Railway, just south of Taylor street, and to replace them with bridges having no center pier, of the bascule type. By carrying out this plan navigation is greatly benefited at the same time that the flow of water which we require is provided for. I transmit herewith plats in triplicate showing what we wish to do at the railroad crossing, which, in brief is to remove the existing swing bridge downstream far enough to admit of building the new bridge. The time during which the old bridge would have to be operated on the site to which we propose removing it will be about one year. We propose to leave one channel, on the east side open for navigation with a clearance of not less than forty-eight (48) feet at right angles to the line of navigation. Will you grant us a permit covering the conditions outlined so that we may proceed to do the work?

Respectfully submitted,
WILLIAM BOLDENWECK,
President.

1st Indorsement.

U. S. Engineers Office.
Chicago, Ill., December 21, 1898.

Respectfully forwarded to the Chief of Engineers, U. S. A.

The existing bridge is one of the worst obstructions in the Chicago River, which will be removed on the completion of the proposed bridge. The latter is designed to meet the views of the officer in charge of this District with reference

to obstructive bridges across Chicago River as expressed in the annual report of the Chief of Engineers for 1896, inasmuch as the design proposes a clear central channel 120 ft. wide measured perpendicularly to the axis of the river. It is the largest plan of the type yet proposed (about 270 ft.).

I respectfully recommend that the authority be granted to construct the temporary and new bridges under the following conditions, viz.:

1. The new bridge shall have a clear channel span of 120 feet, measured perpendicularly to the axis of the channel.

2. A channel of 17 feet in depth and 48 feet clear width, measured perpendicular to its axis, shall be maintained by the Sanitary District of Chicago during construction of the new bridge, along the eastern bank of the river.

3. The existing and temporary structures with their center pier, protection pier, guide piles, abutments, so far as they project beyond the dock lines and foundations, shall be removed to a depth of twenty (20) feet below Chicago city datum, immediately after the construction of the proposed bridge.

4. The channel of Chicago River throughout the length of the present protection pier, shall be dredged by the Sanitary District for the full width of 120 feet, to a depth of 17 feet below Chicago city datum immediately after the removal of the existing and temporary bridges.

5. This authority to lapse two years after its date, if not sooner availed of.

W. L. MARSHALL,
Maj. Corps Engrs.

Whereas, by section 3 of an act of Congress, approved July 13, 1892, entitled, "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," it is declared that it shall not be lawful to construct by authority of the legislative act of a state, any bridge, not already authorized by law, over a navigable water of the United States wholly within the limits of such state, without the approval by the Secretary of War of the location and plans of such bridge;

And whereas, the Sanitary District of Chicago, having authority under an act of the legislature of the State of Illinois, to replace the bridge at the crossing of the Chicago Terminal Transfer Railway, over the South Branch of the Chicago River, just south of Taylor street, Chicago, Illinois, with a

bridge of bascule type, without pier in the river; and also to move the existing swing bridge down stream to a new site, to be operated until the completion of the new bridge, or about one year; and has submitted a map showing the plans and locations of such proposed permanent and temporary bridges, as indicated, respectively, in red and green thereon;

Now, Therefore, This is to certify that the locations and plans of said bridges, as shown on said map, which is hereto attached, are hereby approved by the Secretary of War, subject to the following conditions:

1. That the new bridge shall have a clear channel span of One Hundred and twenty feet, measured perpendicular to the axis of the channel.

2. That a channel of 17 feet in depth and 48 feet clear width, measured perpendicular to its axis, shall be maintained by the Sanitary District of Chicago during construction of the new bridge, along the eastern bank of the river.

3. That the existing and temporary structures with their center pier, foundation pier, guide piles, abutments, as far as they project beyond the dock lines, and foundations shall he removed to a depth of 20 feet below Chicago city datum immediately after the construction of the proposed bridge.

4. That the channel of Chicago River throughout the length of the present protection pier, shall be dredged by the Sanitary District for the full width of one hundred and twenty feet to a depth of 17 feet below Chicago city datum immediately after the removal of the existing and temporary bridges.

5. That the authority herein given shall lapse two years after the date hereof, if not sooner availed of.

6. That the work herein permitted to be done shall be subject to the supervision and approval of the Engineer Officer of the United States Army in charge of the locality.

Witness my hand this 13th day of January, 1899.

R. A. Alger,
Secretary of War.

(War Office Seal.)

THE SANITARY DISTRICT OF CHICAGO.

Chicago, April 26, 1899.

Hon. Russell A. Alger,
Secretary of War,
Washington, D. C.

Dear Sir:

We respectfully ask permission to construct a cofferdam along the west side of the Chicago River, as shown on the accompanying drawings. The cofferdam is to be constructed of piles and timber, and filled with clay. All material of the cofferdam to be removed at the completion of the improvements, or sooner, if, in your opinion, the demands of navigation require it.

Very respectfully submitted,
WILLIAM BOLDENWECK,
President.

1st Indorsement.

U. S. Engineer Office.
Chicago, Ill., May 1, 1899.

Respectfully forwarded to the Chief of Engineers, U. S. A.

This cofferdam is necessary to enable the trustees of the Sanitary District to construct their by-pass on the west side of Chicago River between Adams and Van Buren streets, heretofore authorized by the Secretary of War.

I respectfully recommend that the authority asked be granted on conditions that:

1st. A practicable passageway for vessels of the largest class navigating Chicago River shall at all times during the continuance of this cofferdam be kept open and of dimensions shown on the map, and of the depth now available.

2nd. That immediately upon completion of the by-pass the cofferdam, and all debris attending its construction and use, shall be removed from the channel to a depth of 17 feet below Chicago city datum.

3rd. That this authority shall lapse and become void by limitation two years from this date, if not availed of before the expiration of that time.

W. L. MARSHALL,
Maj. Corps Engrs.

Whereas, by Section 10 of an Act of Congress, approved March 3, 1899, entitled "An Act making appropriation for the construction, repair and preservation of certain public works on rivers and harbors, and for other purpose," it is pro-

vided that it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner, alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same;

And whereas, the Sanitary District of Chicago has applied to the Secretary of War for permission to construct a temporary cofferdam along the west side of Chicago River, at Chicago, Illinois, as shown on the attached blueprint; which work has been recommended by the Chief of Engineers, subject to the conditions hereinafter set forth;

Now, Therefore, This is to certify that the Secretary of War hereby gives unto said Sanitary District of Chicago permission to construct a temporary cofferdam along the west side of the Chicago River, at said place, as shown on said blueprint, subject to the following conditions:

1. That a practicable passageway for vessels of the largest class navigating Chicago River shall be at all times during the continuance of this cofferdam, kept open, and of dimensions shown on said blueprint, and of the depth now available.

2. That immediately upon completion of the by-pass the cofferdam and all debris attending its construction and use shall be removed from the channel to a depth of 17 feet below Chicago city datum.

3. That this authority shall lapse and become void by limitation two years from its date, if not availed of before the expiration of that time.

4. That the work herein permitted to be done shall be subject to the supervision and approval of the Engineer Officer of the United States Army in charge of the locality.

Witness my hand this 12th day of May, 1899.

G. D. Meiklejohn,
Acting Secretary of War.

(War Office Seal.)

THE SANITARY DISTRICT OF CHICAGO.
Chicago, Feb. 27, 1899.

Hon. Russell A. Alger,
Secretary of War,
U. S. A.,
Washington, D. C.

Sir:

On December 12th I wrote you in relation to the proposed substitution of bridges of the bascule type for the center pier swing bridges now in use at Taylor street, and by the railroad company crossing the Chicago River just south of Taylor street, asking at that time for a permit of the work necessary to be done at the Railroad Bridge, which permit you kindly granted under date of January 13, 1899. I now ask that you issue a corresponding permit for the work to be done at Taylor street in accordance with the plans submitted herewith, showing the location of the abutments, protection pier, and the width and alignment of channel which will result from this construction.

Very respectfully,
WILLIAM BOLDENWECK,
President.

1st Indorsement.

U. S. Engineer Office.
Chicago, Ill., March 1, 1899.

Respectfully forwarded to the Chief of Engineers U. S. A.

The proposed bridge will much improve navigable conditions at Taylor street by the substitution of a central channel draw span 120 feet clear width, for two 45 feet draw spans, but the new bridge cannot be constructed before the existing structure is entirely removed, without interrupting navigation, on account of the local conditions here, that are shown on the maps submitted.

I recommend that authority be granted for the construction of the new bridge as proposed, provided that the following conditions be accepted by the Officials of the Sanitary District of Chicago.

1st. The existing bridge at Taylor street, including its center and protection piers and foundations shall be entirely removed, to a depth of 22 feet below Chicago city datum, before any work of construction whatever is done under the new designs, and the channel put in navigable condition and so maintained during construction.

2nd. That upon the completion of the new bridge the officials of the Sanitary District of Chicago shall at once cause the new channel for its full width and for 150 feet on each side of the structure to be dredged to the full depth established in the Chicago River by authority of law.

3rd. That this authority will lapse and become void if not availed of within two years from its date.

W. L. Marshall,
Major Corps of Engrs.

Whereas, by Section 9 of an Act of Congress, approved March 3, 1899, entitled "An Act making appropriations for the construction, repair and preservation of certain public works on rivers and harbors, and for other purposes," it is provided that bridges, dams, dikes, or causeways may be built under authority of the legislature of a state, across rivers and other waterways, the navigable portions of which lie wholly within the limits of a single state, provided the location and plans thereof are submitted to and approved by the Chief of Engineers and by the Secretary of War before construction is commenced;

And whereas, the Sanitary District of Chicago, having authority under an Act of the legislature of the State of Illinois to replace the bridge across the South Branch of the Chicago River, at Taylor street, Chicago, Illinois, with a bridge of the bascule type, without pier in the river, has submitted a map of the location and plans of the same, which have been approved by the Chief of Engineers;

Now, Therefore, this is to certify that the map of location and plans of said bridge, which are hereto attached, are hereby approved by the Secretary of War, subject to the following conditions:

1. That the existing bridge at Taylor street, including its center and protection piers and foundations shall be entirely removed, to a depth of 22 feet below Chicago city datum, before any work of construction whatever is done under the new designs, and the channel put in navigable condition and so maintained during construction.

2. That upon the completion of the new bridge the officials of the Sanitary District of Chicago shall at once cause the new channel for its full width and for 150 feet on each side of the structure, to be dredged to the full depth established in the Chicago River by authority of law.

3. That this authority shall lapse and become void if not availed of within two years from its date.

4. That the Engineer Officer of the United States Army, in charge of the District within which the bridge is to be built, may supervise its construction, in order that said plans shall be complied with.

Witness my hand this 10th day of March, 1899.

R. A. ALGER,
Secretary of War.

(War Office Seal.)

UNITED STATES ENGINEER OFFICE,
#1637 Indiana Ave., Chicago, Ill.
April 24, 1899.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.,
Washington, D. C.

General:

I have the honor to report as follows on the application of the trustees of the Sanitary District of Chicago for authority to open their drainage canal. It is a strange fact that this city has expended, or will expend, over $30,000,000 with the intention of diverting an apparently unlimited amount of water from the Great Lakes to the Mississippi drainage area for sanitary purposes without finding out whether such diversion would be allowed by the great interests of the United States and the Colonies of Great Britain along the chain of Great Lakes in the navigation of the rivers and harbors of the Great Lakes. Now, they ask the authority of an executive officer of the United States to open a channel that will to some unknown extent, lower the levels of all the Great Lakes below Lake Superior and of their outlets, introduce a current also unknown and not to be ascertained otherwise than by actual experiment, in Chicago River, the most important navigable river of its length on the Globe, but which is already obstructed by bridges, masses of masonry and bends, and of difficult navigation at best.

The possible effects of this diversion are not known further than that to some unknown degree they will be injurious. Whether the amount of this injury will be so small as to be accepted by the interests affected, in view of the manifest advantages to and apparent necessities of their neighbors, cannot be determined by other than the interests themselves.

It is clear to me that I am not competent to make a recommendation as to what should ultimately and definitely be done.

The matter of what effect the opening of this channel would have on the levels of the Great Lakes has been heretofore submitted to a Board of Engineers. The Board reported that the Great Lakes would be lowered, but that there was not sufficient data to determine the exact effects of the proposed discharge, and recommend extended investigations, which it is believed are being carried on now by the Deep Waterways Commission or Board. They have not reported. In my opinion the abstraction of from 300,000 to 600,000 cubic feet per minute will permanently lower Michigan, Huron and Erie from three to eight inches; not more than eight nor less than three, corresponding to an extreme reduction of from 160 to 466 tons in carrying capacity of the large vessels of the lakes, and that it will take from three to four years for this full effect to be obtained. But the state law is unlimited in its requirements. 20,000 cubic feet per minute must be taken from Lake Michigan for each 100,000 population of the District; already nearly 400,000 cubic feet must be taken, and at the same ratio of increase for a few decades, in a very short time there must be taken 1,000,000 c. ft. per minute under this indefinite law. The amount should be limited and the injurious effect stopped somewhere.

The mean current to be introduced in Chicago River upon the opening of the canal is estimated by the Engineers of the Drainage Board at 1¼ miles per hour, or 110 feet per minute. This is simply an assumption that with such velocity in an unobstructed river, the amount of 300,000 cubic feet per minute can be discharged through Chicago River,—but I have seen this river so jammed with vessels, drawing all the water that is in it,—that by leaping from deck to deck I could cross the river. What the velocity would be in such conditions, with Lake Michigan on one side and a great fall on the other side of such vessels, no one knows. But it is a simple mathematical problem to determine the effect on steel-plate vessels of from 2,000 to 4,000 tons mass drifting upon or striking stone piers with a velocity of near 2 feet a second. They will go to the bottom.

Individually I have to say that I am in entire sympathy with the people in their effort to purify their water supply. I have lost my only son from typhoid fever, produced, I believe from drinking water polluted by defective drainage at Chicago, which this channel will correct. In every proper way I have aided the officers of the Drainage District. I would like further to aid them, but I believe this question

to be entirely out of my sphere, and too great and important for me even to venture an opinion or make a recommendation about. Yet I may venture to suggest that the entire subject be referred to Congress for final solution, and that a conditional permit or authority be granted to the authorities of the Chicago Sanitary District by the War Department, awaiting action by Congress, to open their channel, and under the following conditions:

1st. That if, at any time, it becomes apparent that the current created by such drainage works in the South and Main branches of Chicago River, be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its South Branch.

2nd. That the Sanitary District of Chicago must assume all responsibility for damages to property and navigation interests by reason of the introduction of a current in Chicago River. With 300,000 cubic feet per minute discharge, it will take one year to lower the level of Lakes Michigan and Huron 1/10 of a foot, and several years to reach the maximum permanent effect of this discharge, which will not probably much exceed three inches, so that the main injury to navigation, if any that can be expected before action by Congress, will be in Chicago River, and that can be at once abated.

All the changes made by the Sanitary District of Chicago, taken by themselves, have been such as to increase the navigable capacity of Chicago River. Taken in connection with the current to be introduced I am not able to say that the river will be as navigable as it was before these changes were made. The changes materially lessen the probable injury to navigation of this current, at the points where the changes have been or will be made.

I believe their channel will be entirely under control and that if the discharge be injurious it can be at once and at any time shut off, and it is evident that the War Department should preserve the right to control the current and discharge through the Controlling Works of this channel.

Very respectfully,

Your obedient servant,

W. L. MARSHALL,

Maj. Corps of Engineers, U. S. A."

Recess at 2 o'clock P. M.

Thursday, June 18, 2:30 P. M.

ISHAM RANDOLPH, a witness called in surrebuttal on behalf of the Sanitary District was first duly sworn by the Commissioner and testified as follows:

Direct Examination by Mr. Adcock.

Q. What is your full name?
A. Isham Randolph.
Q. Where do you reside?
A. In the City of Chicago.
Q. What is your business?
A. I am a civil engineer.
Q. Will you state your education and experience as civil engineer?
A. My education was in the school of experience. I began as an axeman in 1868, on the B. & O. Railroad, and since that time I have filled every intermediate position up to Chief Engineer.
Q. You were Chief Engineer of the Sanitary District from about 1893, weren't you?
A. From the 7th of June, 1893, to the 31st of July, 1907.
Q. And since that time until about sometime in December, 1913, you were Consulting Engineer for the Sanitary District?
A. I was Consulting Engineer up to the 1st of January, 1913.
Q. You were a member, weren't you, of a Board of Engineers that had to do with the determination of certain matters with reference to the building of the Panama Canal?
A. Yes, I was a member of the International Board of Engineers that decided the type of the canal. And I may further say in regard to that before you leave it that that Board was divided, eight to five; eight in favor of a sea level canal and five in favor of a lock canal. And I was one of the minority.
Q. What experience have you had as a civil engineer outside of your experience in connection with the Sanitary District of Chicago?
A. I was building railroads for 25 years. I have been Consulting Engineer for the City of Baltimore on track elevation; Consulting Engineer for the City of Toronto on track elevation; Consulting engineer for the City of Toronto on water supply.

I have had a great many minor experiences but those are the principal ones. I was Consulting Engineer for the Queen Victoria and Niagara Falls Power Commission to report to the Government of Ontario on the power possibilities at Niagara.

Q. What experience have you had and what studies have you made with reference to the commerce upon the Great Lakes and the vessels that are used to carry freight of various kinds?

A. Do you want me to go in detail into that?

Q. Just your general experience.

A. My attention was first called to that in Buffalo in 1906, when I was sent there by the Sanitary District to represent them in a hearing before the International Waterways Commission. At that hearing, Mr. Livingstone, President of the Lake Carriers Association, made a statement to the effect that the capacity of the lake carriers was 100 tons per inch. He stated how many there were in the service, and that they earned 50 cents a ton; and that a loss of six inches would cut them down 600 tons to the trip, and he figured up a loss of $2,500,000 per annum; and I did not know any better at that time. I swallowed it. But when I got back here and began to think of it, I did not believe there was any such boat on the lakes as that. I got the Blue Book of American shipping and scheduled all the boats on the lakes and figured up their capacity, and there was nothing in sight that ran over 80 tons and a fraction per inch.

That information I kept read for use, and in January, 1907, Mr. Taft gave a hearing in Washington on this subject, on this lake level subject and it was attended by representatives of the Lake Carriers, and all interests.

I went on in advance of the hearing and through Congressman Mann got a copy of the advance report of the International Waterways Commission. I found that they had embodied in that report Mr. Livingstone's statement without even quotation marks.

When I was called upon to address them, I addressed the Secretary as far as I had my address printed, and then paused. He asked me if I had seen the report of the International Waterways Commission. I told him I had; and I thanked him for asking me the question because it gave me an opportunity to call his attention to the statements made in that report. I then gave the statistics which I had.

The Vice-President of the Lake Carriers Association got up and demanded that I withdraw that statement. I asked

him why I should do that. He said: Because you are a civil engineer and don't know how to figure lake tonnage. I asked him how he figured it and he could not tell me. I wrote out the formula and handed it to General Ernst, who was sitting beside Mr. Taft. He looked it over and said: That is correct, and handed it back to me.

Then Mr. Harvey D. Goulder came around and asked me if I would not withdraw that statement. I asked him why. He said because my sources of information were not correct. I produced the Blue Book and asked if that was correct. He said that was authentic and sat down. The International Waterways Commission withdrew its reference to that matter.

Q. On that subject?

A. Yes.

Mr. Hopkins: I move that the entire answer be stricken out as entirely irrelevant, incompetent and immaterial; has nothing to do with the issues in this case; is hearsay. Any determination that he made in that regard is one thing, but discussions and conversations with various people I submit are incompetent and immaterial.

Mr. Adcock: I understand that the answer is simply with reference to his familiarity with the commerce upon the lakes and the capacity of the vessels.

Q. Do you know whether any Congressional Committee visited and inspected the works of the Sanitary District prior to the opening of the channel?

A. Yes, sir, they did.

Q. What committee was that?

A. That was a committee on Rivers and Harbors. I cannot carry all those dates in my mind, but I have them all here. I can refer to that, if I may.

Q. Yes, you may refer to data to refresh your recollection.

Mr. Hopkins: I move that that answer be stricken out as immaterial.

The Witness: You wish to know the date when they made their trip?

Mr. Adcock: Yes.

A. February 23rd, 1898.

Q. What did they do? How many were present?

A. I can't remember the number that were present, but there was more than a quorum of the Rivers and Harbors Committee. I know that. And Mr. Burton, the Chairman of

the Committee, who is now a Senator, was one of the members.

Q. What did they do while they were here?

Mr. Hopkins: Let it be understood this line of questioning is objected to.

Mr. Adcock: On the ground of relevancy and materiality.

Mr. Hopkins: Yes. And it is incompetent what those people did.

A. They were taken by train to various points along the canal where they could see it, winding up at Lockport.

Q. The channel at that time was practically completed, the main channel?

A. It was then about 95 per cent. completed.

Q. The water had not yet been turned in?

A. No.

Q. Did anyone representing the Sanitary District accompany the Committee?

A. The trustees and myself, and I think the clerk of the Board. I don't remember whether the attorney was along or not; I do not think he was.

Q. Did the Secretary of War at any time visit and inspect the works of the District?

A. Yes, sir, he did.

Q. When was that?

A. That was on the 5th of May, 1898.

Q. That was Secretary of War Russell A. Alger?

A. Russell A. Alger.

Q. Was he accompanied by General John M. Wilson?

A. Yes, sir, he was Chief of Engineers at the time.

Q. He was Chief of Engineers. Who else accompanied the Secretary of War and the Chief of Engineers on this inspection trip, and what did they do?

A. Well, John R. Tanner was of the party, and a majority of the Board of Trustees, and I was with them. They went down by train, stopping at points where they could see the channel to advantage, and getting off and looking at it and ending up at Lockport, where they examined the Bear Trap Dam, then in process of construction. We have pictures of the party at the various points along their journey.

Q. Have you got those pictures with you?

A. No, not with me; I have them in my album.

Q. Did the International Waterways Commission visit the works of the District and make an inspection of them?

A. Yes, sir, they did.

Q. If so when, and what did they do?

A. Do you care about the other visit of General Alger?
Q. Did General Alger inspect the works at another time?
A. He was here on the 24th of June, 1899, and made an examination of the harbor and the river, in company with the Sanitary Trustees and myself.
Q. Was the purpose of the work explained to General Alger and General Wilson?
A. Yes, sir.
Mr. Hopkins: Objected to as hearsay.
Mr. Adcock: Q. Then the International Waterways Commission was here October 16, 1906, were they?
A. Yes, sir.
Q. Was that the full Commission?
A. Yes, sir, full Commission.
Q. Including the Canadian members?
A. Yes, sir.
Q. Did they make an examination?
A. Yes, sir, they did; they went through it.
Q. They went down the channel?
A. They went down the channel in a boat. They examined the harbor and the river and the channel. And their hearing was the next day, on the 17th.
Q. Now as Chief Engineer of the Sanitary District, you had to do with the determination of the volume of flow of water through the channel, did you?
A. Yes, sir.
Q. Did you have anything to do with the so-called project of 1900, for the improvement of the Chicago River, and with the preparation of the plans for that project?
A. It was my project, and the plans were prepared under my direction.
Q. Were those plans submitted to the Secretary of War and Chief of Engineers, and approved by him?
A. Yes, sir.
Q. What did you take into consideration in determining the plans for that improvement?
A. I took into consideration that we wanted to pass through the main river, through the South Branch of the Chicago River as far as the Stock Yards Branch 480,000 cubic feet a minute.
Q. That would be about 8,000 cubic feet per second?
A. 8,000 cubic feet per second. We wanted to take in through the 39th street conduit 2,000 cubic feet per second, 120,000 a minute, making a total of 10,000 cubic feet from the junction of the Stock Yards Branch with the main river.

Q. Did you take into consideration what the mean current would be through the Chicago River and the South Branch and West Fork?

A. I figured it on the basis of a shade under a mile and a quarter an hour, except in bridge openings where it was slightly contracted.

Q. That was the current which the Secretary of War considered proper for navigation purposes was it, at that time?

A. Yes, sir.

Q. Now there were some modifications of the May 8th, 1899, permit, whereby the flow of water was limited. After about 1902, did you as Chief Engineer attempt to keep the flow within the limits of the permit as stated by the Secretary of War?

A. Up to June, 1902, I conformed fairly well to those figures. After that we exceeded them, and paid very little attention to that from that time on.

Q. That is in 1902, improvements were made in the Chicago River so as to create a greater cross-section for the flow of water?

A. In that year we excavated 600,000 cubic yards of earth from the river and we built 4,700 feet of new dock. The narrowest place in the river was beyond 22nd street. It was only 115 feet wide, and we enlarged that to 200 feet; 26 foot, midchannel depth.

Q. In other words those improvements were such that a current would not be created of more than a mile and a quarter an hour with a flow exceeding the limitations which had been indicated by the Secretary of War?

A. That was true, wherever our channel was completed. There were some few narrow spots where the current still exceeded that.

Q. There were not very many of those places?

A. And not very serious.

Q. Rather immaterial, were they?

A. Yes, sir.

(Answer of the witness read as follows: "That was true where our channel was completed. There were some few narrow spots where the current still exceeded that.")

Q. That is at that time?

A. Yes, sir.

Q. Did you ever, prior to the improvements that were made by the Sanitary District, see boats stuck in the river?

A. Yes, sir, a number of times.

Q. Since that time, since the improvements have been made

by the Sanitary District and the City of Chicago, and since the removal of the tunnels—

A. Since the lowering of the tunnels.

Q. Since the lowering of the tunnels, do you know of or have you seen any boats stuck?

A. Once only. Two boats attempted to pass each other in a narrow draw and got stuck.

Q. That was an old swing bridge opening, was it?

A. Yes, sir.

Q. Do you consider that the conditions of navigation in the Chicago River are better now and with the flow of the Sanitary District through the Chicago River and its branches, than it was before the improvements were made and before the channel was opened?

A. I do, absolutely better.

Q. You have been familiar, have you not, with the Chicago River and navigation on that river for a number of years?

A. For 20 odd years.

Q. You have been on the river frequently?

A. Yes, sir.

Q. Taking the project of 1903 of the United States Government for the improvement of the St. Mary's, St. Clair and Detroit Rivers, do you consider that there would have been very much extra expense entailed by excavating deeper, say 6 inches? That is 6 inches deeper than the excavations that were made?

A. The expense would be very inconsiderable.

Q. What do you consider to be the proper amount of water that there should be under the keel of boats?

A. Well, my ideas on that subject I get from a study of what others have said and written.

Q. Yes?

A. My own experience is that on river steamers in the Mississippi and the Illinois, I can always tell as soon as we strike shallow water, no matter where I am on the boat, by the way the engines labor; feel it at once.

Q. Will you refer to some of the discussions of engineers with reference to that subject?

A. Yes, sir.

Q. Give the data?

A. In the report of the Board of Engineers on Deep Waterways from the Great Lakes to the Atlantic, 1901, page 219, I read:

"The speed attained by a ship in open sea will be reduced to

a marked degree on entering shoal water, even of unlimited width."

You will find that on page 219. On page 220, of the same: "Retardation in shoal water. * * * Observations made recently on the freight steamship Angeline, in the deep water of Lake Huron and the shoal water of Lake St. Clair, indicate that the retardation is about 18 per cent. (note, the Angeline is 414 feet long and 51 feet beam; was built in 1899). The depth under the keel was about 2 feet 10 inches, no allowance being made for settlement of the ship in the water which always occurs when the water is shoal."

The Senator (410 feet by 45 feet) is also cited with a loss of 16 per cent. in Lake St. Clair. This Commission provides for two feet of depth below the keel of vessels for which they designed a channel.

Mr. Hopkins: I want to object to this line of testimony, on the ground that it is immaterial. It is incompetent to put in the opinions of other people in this way. There is no objection, however, to the fact that the witness was reading from a copy and not the original report of the people or of the Board, whichever he is purporting to read.

Mr. Adcock: I understand that it has been the agreement and the practice in the course of taking this testimony to refer to reports of engineer officers and even to reports of various engineers which are authenticated, without making it necessary to produce the persons who gave the opinions in the report.

Mr. Hopkins: I understand that has been the practice, but I do not understand it has been the practice at all that merely because of the fact that some statement is made by some official of the Government or of an association, that it thereby becomes competent.

Mr. Adcock: It is used for what it is worth. The source of the statement is being shown and the witness discussing—

Mr. Hopkins: No objection in those cases that the original is not produced.

Mr. Adcock: There is no objection made on the ground it is hearsay, either; never has been.

The Witness: Shall I proceed?

Mr. Adcock: Yes, go ahead.

The Witness: Kent's Engineers' Pocket Book, 1900 Edition, treats of this subject on page 1007.

"The Medusa, a third class cruiser, length 265 feet, beam 41, draft 16' 6", displacement 2,880. Indicated horse power

for ten knots per hour, 700; for 14 knots per hour, 2,100; for 18 knots per hour, 6,400; for 20 knots per hour, 10,000.

Atlantic passenger steamer 525 feet long 63 feet beam, mean draft on trial 21.3, displacement 11,550 tons: Indicated horse power 10 knots per hour, 2,000; for 14 knots per hour, 4,600; for 18 knots per hour, 10,000; for 20 knots per hour, 14,500.

The Medusa's figures for 20 knots are from the trial in Stokes Bay and show the retarding effect of shallow water. The figures for the other ships for 20 knots are estimated for deep water."

Here we have an example of two vessels, one having a displacement of about 4 times that of the other. The larger requiring in deep water only 40 per cent. more power to give it 20 knots speed than was required to give the smaller vessel the same speed in shallow water.

It is a matter of common observation that the bow of a boat in rapid motion rises above the waist line and the stern settles below it. This settling of the stern is called the "squat." This squat is discussed in House of Representatives document number 1,160, 62nd Congress, third session, issued December 12, 1912. The observations were made by direction of Colonel W. M. Black on the Hudson River. On page 35, this table is printed: Speed eight miles per hour; channel depths 12 to 13 feet; squat 1.4. In depths 13 to 14 feet, squat 1.2; in depths 15 to 16 feet, squat .9 of a foot.

Speed 10 miles per hour, the squat in from 12 to 13 feet of water is 2-1/4 feet; in 13 to 14 feet 1.9 feet; in 15 to 16 feet, 1.4 feet.

In the observed case of the paddle wheel steamer Hendrick Hudson, 400 feet long, 45 feet beam, normal draft 9-1/2 to 10 feet, 22-1/2 miles in 135 feet of water, with squat 0.99 foot. In the same depth, 11-1/2 miles per hour, squat 0.15 foot. In water 14.4 deep, speed 9.14 miles per hour, squat 1 foot. In water practically the same depth, the greatest speed she could make was 9.48 miles.

On pages 34 and 35, Colonel Black says: "It is believed that the minimum clearance allowable for safe navigation in the Hudson River is 2 feet. In Germany, the clearance adopted as safe is 1 meter (39 inches)."

On page 100, and following, formulae, tables, etc., relating to the squat and clearance problems are given.

Captain Marshall states in the report of the Chief of Engineers for 1893, Appendix LL, pages 2798-9, in discussing the clearance over tunnels under the Chicago River: "There

should be at least 2 feet between the bottoms of vessels and the crowns of the tunnels to guard against chance obstructions of small extent lodging temporarily over the ridged crowns."

Q. Is it your opinion that the amount of water that should be under the keel of a boat is a matter of feet rather than inches?

A. Yes.

Q. Now assume that you had two or three feet of water under the keel, and say that the depth was decreased so that you would have six inches left, the effect upon navigation would be, perhaps, in the increased consumption of coal, or loss of speed.

A. Loss of speed and an increased consumption of coal. This one experiment shows here that in shallow water they could not get over a certain speed, no matter what power they applied.

Q. Would that increased consumption of coal, say on a trip from Lake Superior to Cleveland, considering the shallow places in the St. Clair River and Detroit River, amount to anything considerable?

A. I believe it would be negligible. I do not believe it could be computed. It must be borne in mind that through those channels the heavy loads are going with the current, and they come light upstream.

Q. Have you made any investigation to determine the amount of horse power that may be produced in the Des Plaines and Illinois Rivers with a diversion of 10,000, 12,000 and 14,000 cubic feet of water per second from Lake Michigan?

A. Yes, sir, I have.

Q. And this is outside of the power that is already developed by the Sanitary District at Lockport?

A. As Chairman of the Internal Improvement Commission of the state, I planned the waterway and water power development from Lockport to Utica, and I had to figure up those things then.

Q. There is available through the Sanitary District plant with 10,000 cubic feet about 30,000 horse power, is there not, at Lockport?

A. Yes, sir.

Q. How much with 14,000 cubic feet?

A. At Lockport it is 43,000 electrical energy.

Q. You are familiar with the market value per horse power of electrical energy in this vicinity?

A. Yes, sir.

Q. Will you give us the amount of horse power that may be developed in addition to that that is developed by the Sanitary District plant, in the Des Plaines and Illinois Rivers, and the market value of such horse power per year?

A. In the Des Plaines and Illinois Rivers below Lockport, with 10,000 cubic feet flowing, 80,000 net electrical horse power, 80 per cent. efficiency, can be produced. With 12,000 cubic feet per second, 96,000 horse power can be produced. With 14,000 cubic feet per second, 112,000 horse power can be produced.

Q. And including Lockport?

A. Including Lockport, 10,000 cubic feet would produce 110,900 net electrical horse power, 80 per cent. efficiency. 12,000 would produce 132,000 net electrical horse power, 80 per cent., and 14,000 would produce 155,000 net electrical horse power, 80 per cent.

Q. What is the market value of that horse power, of that electrical energy, here at Lockport at the place it is produced?

A. That is easily worth $25 per horse power.

Q. That would make a total of how much?

A. For the 10,000 cubic feet per second, $2,750,000; for the 12,000 cubic feet, $3,300,000; for the 14,000 cubic feet, $3,875,000.

Q. What horse power may be developed with the same volumes of water at Niagara Falls, under the practice there?

A. I have taken the maximum case at Niagara Falls which is the Shellcock Power Company. They have a 200 foot head. The other powers range from 135 to 156 feet head, but the Shellcock is the maximum.

Q. 10,000 cubic feet of the Shellcock power is 181,000 horse power. That sells there at $9.50, and it is worth $1,719,500. 12,000 cubic feet per second at the same point would develop 218,000 horse power, at 80 per cent. efficiency in every case, which is worth $2,071,000. 14,000 cubic feet per second would develop 254,400 horse power, and that is worth $2,416,800.

The raw water is selling in the Illinois Valley for nearly twice as much as the developed power is selling for on the busbar at Niagara.

Q. What is the bottom capacity of all the boats and vessels on the Great Lakes?

A. I get at it from two sources: The Blue Book of American Shipping, and the Statistical Report of Lake Commerce, put out by Lieutenant Colonel Mason M. Patrick.

Q. You are taking 1913?

A. 1913, yes, sir. I have it figured out for the 273 vessels over 396 feet long. I have not figured it for the lower class. That amounts to 2,746,576 tons.

Q. How much freight was actually carried in the year 1913?

A. 872 vessels of all sorts carried 79,718,970 tons.

Q. What were the earnings?

A. The freight paid on that was $44,380,864.81.

Q. What could they have earned in addition to what they did earn, had there been sufficient freight to have kept them busy?

A. They could have earned $7,462,085 more.

Q. That is about 25 per cent. more?

A. It is 24 per cent. as near as may be; that is figuring the 273 vessels only without considering the mosquito fleet, the smaller fleet.

Mr. Adcock: That is all.

Cross-examination reserved.

Adjourned subject to notice.

United States of America,
Northern District of Illinois, } ss.
Eastern Division.

IN THE DISTRICT COURT OF THE UNITED STATES

United States of America,
Complainant,
vs.
The Sanitary District of Chicago,
Defendant.
} Equity No. 114.
C. C. No. 29,019.

STIPULATION.

It is hereby stipulated that the following matter, pages 3601 to 3765, inclusive, being extracts from public hearings, briefs, letters, telegrams, and resolutions in connection with the application of the Sanitary District of Chicago of February 5, 1912, to divert 10,000 cu. ft. of water per second from Lake Michigan, may be considered in evidence with like effect as if witnesses were called and originals were produced and identified in this case, subject, however, to all objections as to materiality and competency.

J. H. WILKERSON
United States Attorney.
EDMUND D. ADCOCK
Attorney for Sanitary District of Chicago.

CHICAGO, August 12, 1914.

EXTRACTS FROM PROCEEDINGS BEFORE THE SECRETARY OF WAR IN CONNECTION WITH THE APPLICATION OF THE SANITARY DISTRICT OF CHICAGO, DATED FEBRUARY 5, 1912, FOR PERMISSION TO DIVERT 10,000 CUBIC FEET OF WATER THROUGH THE CHICAGO RIVER AND THE CALUMET RIVER.

Proceedings February 28, 1912, before Secretary of War, Henry L. Stimson.

Appearances for Sanitary District:

John C. Williams, Esq., Attorney; George M. Wisner, Chief Engineer; Thomas A. Smyth, President; and Thomas M. Sullivan and Thomas J. Healy, Trustees for the Sanitary District.

Stephen A. Foster, representing certain interests in Calumet district; E. C. Lindley, former attorney for the Sanitary District; Lawrence McGann, Commissioner of Public Works of Chicago; Dr. A. B. Young, Health Commissioner, Chicago; Lyman E. Cooley, civil engineer representing Finance Committee of Chicago; W. D. Weis, Hammond, Indiana; A. C. Barlow, Chicago; and Professor Barto, University of Illinois.

Also Representatives Madden, Mann, Wilson, McDermott, Sabath, Gallagher, Evans, Foss, Copley, Rodenberg, Foster, of Illinois; Senator Kern and Senator Shiveley and Representative Crumpacker, of Indiana.

Opposing application of Sanitary District:

Messrs. John Kennedy, W. J. Stewart, and David Seath, representing the Department of Marine and Fisheries of the Canadian government.

William Livingston, president of the Lake Carriers Association; Harvey D. Goulder, attorney for the Lake Carriers Association; and Arthur C. Sullivan, of the Chicago Board of Commerce; representing the navigation interests.

Senator William Alden Smith and Representatives James C. McLoughlin and Francis H. Dodds, of Michigan.

J. T. Blackstock, representing Canadian power interests; George H. Eichelberger, representing Cleveland Chamber of Commerce; Fred C. Signer, representing Association of Lake Lines; J. H. Davidson and H. A. Cooper, Representatives from Wisconsin; Mr. Bruce of Milwaukee; H. B. Ford and Edward T. Cahill of Chicago.

John C. Williams, Esq., in his opening statement, read the application for the permit, copy of which is as follows:

"The Sanitary District of Chicago.

Chicago, February 5th, 1912.

Sir:—

On behalf of the Board of Trustees of The Sanitary District of Chicago, I have the honor to apply for enlargement of the terms of an instrument executed by The Secretary of War May 8, 1899, as modified by instruments similarly executed on December 5, 1901, and June 30, 1910, respectively, in the following particulars and in view of the facts hereinafter set forth, to wit:

The flow of water from Lake Michigan through the canal of The Sanitary District of Chicago is now limited by the said instruments to 4167 cubic feet per second.

The population of the Sanitary District, the sewage of which is to be disposed of through the channels constructed and to be constructed by the said District, exceeds 2,500,000 persons and is rapidly increasing. The only method at present available for disposing of the sewage of this population is by diluting the same with water withdrawn from Lake Michigan and flowing through the Chicago Drainage Canal. The least amount of water necessary to render sewage innocuous by the dilution method has been estimated by well recognized sanitary experts as 1,000 feet per second for every 300,000 inhabitants; so that the amount permitted to be withdrawn by the instruments to which reference has been made is much below the amount at present needed by the District.

The Sanitary District has been for some time engaged in investigating methods and devising plans for the treatment of the sewage with a view to requiring less water for its safe dilution in the future. The methods of other states and countries for such treatment of sewage, are not as yet entirely satisfactory to all concerned, and any changes of methods for large cities must necessarily require several years.

Until these experiments are concluded and proper works installed, the use of additional water from Lake Michigan is essential to the health of the large population of the City of Chicago and of the Sanitary District and of those who live adjacent to the Des Plaines and Illinois rivers into which such waters are discharged.

Subject therefore to such restrictions as to you may seem proper for the protection of the public interest, and to such a method of supervision as you may suggest to promote the general welfare, and pending the completion of the investigations now being conducted to render the use of increasing quantities of water in the future necessary; I have the honor to apply for permission for The Sanitary District of Chicago to withdraw from Lake Michigan through the Chicago river and Calumet river—not to exceed ten thousand cubic feet of water per second; such permission to be revocable at any time by The Secretary of War, and subject to such action as the Congress of the United States may see fit to take in the premises.

Respectfully submitted,

George M. Wisner,
Chief Engineer.

Hon. Henry L. Stimson,
Secretary of War,
Washington, D. C."

Statement of Hon. William Alden Smith of Michigan.

"Mr. Secretary, I represent the unanimous opinion of the Congressional delegation from Michigan in opposition to this application * * *."

Statement of Mr. E. C. Lindley.

"In order that those who oppose this application may know the exact situation, I will in about ten minutes time, attempt to state it. It was in 1889 when the state of Illinois and city of Chicago determined that there must be relief in the way of the disposal of the sewage of that city. The state passed a law pursuant to its police power to provide for such, authorizing the construction of the main channel of the Sanitary District diverting the Chicago river so that it would empty into the Des Plaines river, drawing the water from Lake Michigan so as to take the sewage of the city away from the water supply of the city.

That tunnel was begun in 1889, was completed in 1900, and was opened, as I recall it, in January, 1900, after permits by the government to divert the Chicago river.

The Sanitary District has spent in the completion of its main channel and its subsidiary channels, in the neighborhood of seventy millions of dollars to provide for the disposal of the sewage of the city of Chicago so that sewage would not pollute its water supply and would not pollute the waters of Lake Michigan. In that expenditure, Mr. Secretary, it spent in the neighborhood of eleven millon dollars in widening the Chicago river, in replacing center pier bridges with bridges without anything to obstruct the vessels in the use of the river. So that it should be borne in mind that what the city of Chicago is attempting to do is not detrimental to the commerce of the lakes, but so far as the river is concerned is an improvement of that river in the interests of commerce, while at the same time protecting the lives of the people of the city of Chicago. I have never heard of the objection which Senator Smith makes this morning until this morning. Although I have been in many discussions, and with all due deference to the distinguished Senator, I hardly believe that the withdrawal of the small amount of water suggested is going to change materially the temperature of Western Michigan. We have heard heretofore that the withdrawal of this water would lower the level of the lakes and for that reason commerce might be affected, but as I

understand it even the opponents concede that if the level of the lakes was to be reduced the maximum amount they could have theoretically, that the reduction would not eventally exceed five inches.

Secretary Stimson: Do you know how it compares, the total flowage that is asked for, with the flowage through the St. Clair river, for instance?

Mr. Lindley: I did know, but I can't say off hand. I don't know what the flowage is through the St. Clair river.

Mr. Williams: About two hundred and twenty thousand cubic feet per second.

Mr. Lindley: About two hundred and twenty thousand cubic feet per second, I am told.

Secretary Stimson: Through the St. Clair?

Mr. Lindley: Through the St. Clair, so that the amount which we are asking would be about five per cent.

Now, Mr. Secretary, it is not proposed that this ten thousand cubic feet per second should be taken through the Chicago river. Eventually when the measurement of ten thousand requested is used only six thousand of it will go through the main channel or through the Chicago river. Two thousand cubic feet per second is to be taken through a tunnel or conduit which has been constructed at 39th street connecting with the main channel where it connects with the Chicago river. Two thousand cubic feet per second is to go through the Calumet channel now being constructed, the construction and completion of which is necessary as Judge Foster suggested, to give relief to the large portion of the city lying south of 87th street comprising a number of boundary towns, including the towns on the Indiana side of the line.

In other words, here is a project upon which seventy millions of money has been expended on condition that this amount of water which was recommended by the International Waterways Commission was to be appropriated for this purpose; so that the state of Illinois and the city of Chicago and the state of Indiana, if you please, are here only asking that you now approve a permit to take that amount of water which the International Waterways Commission had in mind to be appropriated to this purpose, and if I am not misinformed, when that report was crystalized into a treaty each of these two governments, the Canadian and the United States governments, were given permission to take a certain amount of water to be taken without going to that Commission was determined by including so much water for power purposes at Niagara and so much water for sanitary purposes, and it

must be remembered, gentlemen, that that Commission laid emphasis upon the proposition that the use of water such as is being made by Chicago and the district is the highest use of water.

I do not need to argue before you, Mr. Secretary, that from time immemorial domestic and sanitary purposes have had preference over manufacturing or commercial purposes, and that this is, as Judge Harlan said in the Supreme Court decision, the highest use to which the water can be put. Without the people there can be no commerce and without the people we will not need the peaches heard of; Chicago wants the peaches and wants the commerce, but along with it she wants to conserve the lives of her people and we do not believe that the small amount of water which we are asking for is going to be detrimental to either of the two interests.

If I were to take sides voluntarily for a mere commercial standpoint, I believe I could make a better argument that the commerce of the United States would be better subserved by the diversion of some water here sufficient to develop the so-called deep waterways, but we are not here arguing for that purpose today. We are here simply pursuant to the direction of the state of Illinois that we shall complete this work upon which we have spent so much money. In other words, and I will conclude my opening, Mr. Secretary, because I want to leave the time for the attorney to close, under the law by which these works have been begun, the district is enjoined to take from that channel sufficient water to dilute the sewage so as not to injure the health of the people below and so the water of the Illinois river and the Mississippi river will not be so polluted as to injure the lives of the people of the cities down that river. The law provides that the district must pass through the channel twenty thousand cubic feet per minute for every one hundred thousand people within its confines. The last census, as I recollect, gave the city of Chicago two million one hundred thousand people. Compliance with the Sanitary District therefore requires that there should be flowing through something like over four hundred thousand cubic feet per minute. The permit which you or your predecessor heretofore issued, does not permit that amount of diversion and it does seem to me that the Sanitary District has a right to be put in a position whereby it can comply both with the state law and the federal law.

Secretary Stimson: Of course, Mr. Lindley, you appreciate that my jurisdiction is concerned only with navigation.

Mr. Lindley: It is concerned only with navigation I appreciate.

Secretary Stimson: I have no right to balance off the rights of navigation against any other right. I have only the right to say whether or not the rights of navigation are impaired or affected or whether they are likely to be affected by the application in question.

Mr. Lindley: Yes, sir, I understand.

Secretary Stimson: And of course the state law that you cite is addressed to an entirely different purpose.

Mr. Lindley: Yes, sir.

Secretary Stimson: A sanitary purpose which is not within my jurisdiction and which does not affect me.

Mr. Lindley: Not in one sense, Mr. Secretary. I argued before Mr. Taft here that in view of the decision that the sanitary purposes were the highest purposes, that unless the opposition could show that there would be substantial interference, that it was as a matter of right the right of these people to take that water and that question is in the courts and is yet undetermined, but aside from that what I do impress upon you is that the government has been aware all the time that this amount of water was required by the law under which these works were constructed and the works have gone on with the knowledge of the federal government and therefore the federal government should put those who have placed their works in that condition in a position to comply with that law unless there is something more than imaginary objections in the way of a substantial interference with the commerce of the states.

Secretary Stimson: I appreciate the force of that argument, of course, but my suggestion was only in the way of narrowing down the argument as to whether or not there was such substantial things because however pressing the other I will assume the sanitary needs of Chicago are great and pressing but what I want are the facts which guide and justify my jurisdiction.

Mr. Lindley: * * * I can only say, Mr. Secretary, that three years ago when I went into this question, when with the Board, that the evidence showed the actual diversion which has taken place has not lowered the level of the Great Lakes. That the level of the Great Lakes at that time was higher than when the canal was opened, but I do not believe that would be the fact today; that the level fluctuates from a foot and a half to three feet in a great many years and as I say, even the opponents of this do not contend that eventually the max-

imum reduction in the level would exceed five inches for all the water that might be diverted if this application is granted, and therefore that the additional reduction occasioned by the request would not exceed two or two and a half inches."

Statement of Hon. James H. Davidson of Wisconsin.

"Mr. Secretary, every city on the east coast of Wisconsin is represented here today, Kenosha, Racine, Milwaukee, Sheboygan, Manitowoc, Two Rivers, Sturgeon Bay, Green Bay and Marinette. They are vitally interested in this question. It is a condition and not a theory that confronts us. The present level of Lake Michigan is as low as it has ever been. In fact but once has it been as low as it is now. It has gone in circles of from seven to ten years up and down.

The drainage canal was opened in 1900. It was the argument of those favoring that proposition that the lakes continued to rise after it was opened and quoted that as a demonstration that the diversion through the drainage canal did not affect the lake level. The fact that in those years 1889 and 1900 and 1905 to 1906 were the years of the up-turn of the cycle. During that up-turn, however, after this canal was opened, Lake Huron and Lake Michigan never attained the previous high level that they had attained at every one of the up-turns of the cycle theretofore since 1860. In other words the pool was not created. It can be charged to nothing else in my judgment than the diversion at Chicago. The result has been that instead of representing the high water part of the up-turn it only represented a point lower than the average from 1860 to the present.

Secretary Stimson: Do you know how much lower, sir?

Mr. Davidson: Something about half a foot as I recall. I am not positive about that.

A Bystander: About a foot and a half lower than high water.

Mr. Stimson: I mean the average.

Mr. Davidson: It commenced to recede and from that time it has been continuously going down and more rapidly than ever before. Why? Because the pool has not been created on the up-turn that had theretofore been created. Hence we maintain that the present existing low level of the lake is almost if not entirely caused by the diversion at Chicago. They have permission to extract something like four thousand cubic feet—four thousand one hundred and sixty cubic feet—

Mr. Secretary: Four thousand one hundred and sixty-seven.

Mr. Davidson: The information in the report sent in to Congress shows that they have extracted about seven thousand cubic feet, we believe and charge the fact to be upon information, that they have been and now are extracting, diverting through the drainage canal an amount almost double the amount permitted under the authority of the Secretary of War heretofore granted. The fact is that all of the harbors on the west shore of Lake Michigan are exceedingly low. This fact must be borne in mind. The policy of the general government has been in connection with the harbors of the lake. The general policy has been to improve the harbors to the shore line. The municipality deals with the question inside the shore line.

I have been a member of the committee on Rivers and Harbors for fourteen years and during that entire time that policy has been maintained. The result has been that every municipality in my state has spent large sums of money by bonding itself and otherwise to dredge out the inner channel to a depth suitable to the navigation of the lakes and commerce of the lakes. The government has been to a large expense in getting the channel outside the shore lines to the depth that has been dredged by different ports. This diversion if continued and the lowering of these levels if continued, necessarily means an extraordinarily heavy burden upon these municipalities in order to restore the commercial facilities that have been provided and restore them to their original condition of usefulness. Take the situation at Green Bay for instance, which city is represented here because of the very great interest it has in the question. The channel flowing from Fox River into Green Bay comes out through the bay for a long ways and the bay is shallow. It has been a tremendous expenditure to the government to maintain that channel out through the shallow portions of Green Bay. Consequently the reduction of the level permanently means that that expense must be very largely increased in order to maintain the commercial facilities there.

We insist that while Chicago is entitled to a reasonable amount of water, and I would not be narrow about it, I want them to have what is necessary for sanitary purposes—it must be under that system of sanitation which the world recognizes as the most successful and the most useful and that is not the dilution system.

They have constructed a great canal and at a tremendous cost, as the gentleman has stated. They did it upon their own responsibility and they could not have expected when they constructed that canal that it could be a permanent method of the disposal of sewage as the city would grow because it is evidence on the face of it that they could not keep up with the growth of the population by diverting the water from Lake Michigan to supply the necessary amount for that purpose. I maintain that we on the lakes have had no participation in the court's decision to which I refer by which under the law the drainage district is obliged to take an amount sufficient to dilute the sewage to a sanitary condition. We are not parties to that transaction. The commercial cities of Wisconsin have not been parties to it in any sense or at any time.

Secretary Stimson: I do not think that that was cited as binding on the government at all.

Mr. Davidson: I should hope not.

* * * * *

Mr. Davidson: Now in the first place we object to any further diversion than is now permitted. We believe there ought to be government regulation of the diversion and that the diversion should be held strictly to the amount permitted by the Secretary of War. We do not believe the necessities of sanitation, eliminating the power contracts and the use of water for power purposes which the drainage canal commission now enjoy, should be used to emphasize their demand for a greater flow of water. We believe that the flow now is more than is necessary for sanitation and hence we believe that this permit should be denied. The commercial interests of the state of Wisconsin are greatly affected by it and are opposed to the granting of this permit. * * *

Mr. Secretary, I have been asked if the cities in Wisconsin have contributed of their own funds for the creation of these channels on the lake. I will say all of them have. Kenosha, Racine, Milwaukee, Sheboygan, Manitowoc, Two Rivers, Green Bay, Marietta and Kewaunee, without exception. They have dug the channels inside the shore line and have spent millions of dollars by bonding themselves and have created terminal facilities to the shore line and into the mouth of the little river that usually runs into the lake at each of these ports.

Statement of Harvey D. Goulder, Cleveland, Ohio.

"* * * I have had occasion to argue the duty of the United States government to either wholly take charge or in common with the community, state or municipality take part in deepening the harbors because of the depth of the channels through the Great Lakes. We are doing what they are doing to improve the railroad. Of course you can see that the trunk line cannot expand beyond the capacity of its terminals. What has been spent by localities other than Chicago on its terminals? That is what I want. A very large share of authority is vested in this department and the head of this department with reference to the conservation and regulation of these waters for navigation purposes and the expenditure of many millions of dollars is intrusted to this department for that purpose. Now the question that is presented here to me as a lawyer, as a legal proposition and as a proposition in philosophy is this. Whether the department that is intrusted with the regulation and control of these waters for navigation purposes under the authority in our constitution to regulate commerce through the commerce clause and nothing else, whether when it becomes perfectly manifest and is conceded as I think it must be in all integrity, that that interest will be harmed and injured by taking water away from those navigation purposes, whether this department shall say 'We will permit that diversion, we will permit that impeirment because in some question of sanitation or right or power or something else in the opinion of the Secretary of War the public or some portion or some faction of the public may be better served in another direction.'

Mr. Secretary: You need not argue that proposition. I shall call upon the other side to argue that.

Mr. Goulder: I ask whether that determination as a matter of reason should not be rather with Congress than with any department and I think the solution of this thing is to let Congress determine it.

Secretary Stimson: What I shall confine my examination to is the question as to whether or not navigation is impaired or would be impaired by any additional diversion of the water.

Mr. Goulder: As to the reduction of the level I think it is a mere waste of time for the Secretary of War to listen to any advocates or opponents of this measure. We have the best authority in the world on that subject right in this de-

partment. We have simply to call upon the office of the Engineering corps to get that kind of information which is absolute both in its integrity and in its authority. I make then only this further point. We do not like to be in a position as we have been—Mr. Livingston has been and I have been and we have all been in the position—that we are unwilling to give water for health purposes and all that sort of thing. Everybody recognizes that. We do not go into the technical question whether a city is a riparian proprietor or anything of that sort. We say this. We say that all reports, which I will submit to you in a brief, all the reports made to this commission before they made the expenditure showed that it was unnecessary to resort to this measure, that it could be taken care of by filtration and the cost would not be so very much different. If I understand they want this for the accommodation of Chicago south of 87th street. As I say it was originally reported that it was unnecessary to resort to this measure and that it could be taken care of by filtration without very much greater expense. There are other reports on file here. They were before Secretary Taft when he was Secretary of War.

* * * Further than that we had our hearing here in 1907 and the then President of the Sanitary Board stated as among the possibilities that this Calumet river being entirely within the boundaries of Illinois, it was not necessary to have a permit from the Secretary of War, to which Mr. Taft responded pleasantly, 'Then shall we treat this merely as a visit of courtesy, this hearing?'

Secretary Taft refused that permit. We were before him then under very much the same circumstances that we are here now.

Then an arrangement was made that they should go forward claiming that it was not necessary to have the permission of the United States and undertake to do that work. Thereupon an injunction was brought by the United States government and they claimed on the part of the drainage canal that there would be no substantial loss or interference with navigation. The case has been pending ever since 1907, I think it is.

* * * Some of the gentlemen who have come here have fallen into the very bad habit of thinking the shipping interest is the interest of the ship owner. It is nothing of the kind except in a very small degree. The shipping interest is the broad public interest and the whole country is interested and

every part of the country is interested in cheap navigation, cheap freight, a freight that probably every year repays all the money that the government has ever spent on the channels of the Great Lakes and we go in on that, not that the mere owner of the ship is the man to be regarded, it is the public. Therefore I say that when they say 'We have spent a whole lot of money' and there is nothing against that except the mere temporary interest for gain of the ship owner, we say that over against that can be matched every dollar the government has spent on these other channels and every dollar that the ports on the lakes have spent for terminals. That is the interest of the other side.

* * * Now what superior right has Chicago to the use of these waters for domestic purposes. Other places have just as good right to the water as Chicago.

Some day we may have a canal cut through from the Ohio River to Lake Erie and then it will be a question there as to the amount of water to be taken from the lakes. There are various communities that need this water or will need it in the future. They have the same right as Chicago to take water for these purposes.

In closing let me say this, that the use of water for taking care of the sanitary condition of the city of Chicago by dilution is something that we have outgrown. In every city, in every place along the lakes in Cleveland, in Buffalo, in every place except Chicago, we find that we are talking about filtration. We will talk about filtration in Cleveland for example. In the case of filtration we do not take the water away from the lake permanently, we take the water and run it with the filter into the lake. We want to have filtration and we shall have it, and it is going to be soon, and so in the case of Chicago. Chicago can do that. * * *"

Statement of Mr. Bruce, Representing the Greater Milwaukee Association of Milwaukee, Wisconsin.

"While we stand here and discuss and show you that Chicago has no right to get water for sanitary purposes because there are other means for sanitation disposal and while we believe that the state of Illinois has no right to get the water for power purposes because there are other means for securing power, we want to confine ourselves strictly to the question of navigation.

By way of navigation facts I want to say that our engi-

neers in Milwaukee have figured out that if this additional grant for water is given, it will reduce the level of Lake Michigan by fully eight inches, but if it were only six inches in the way of concrete facts, Milwaukee maintains three navigable rivers. We estimate that a dredging of six inches which will be necessary will be done at a cost of about one hundred and fifty thousand dollars. This is simply a concrete fact which might be added to the sum of information and which of course will multiply itself so far as applies to other localities.

Secretary Stimson: It would not need dredging, would it, a lowering of six inches?

Mr. Bruce: Here is the point I want to make on that score. Here we are at a low water point, the lowest we have had at at least thirty years. Now when the lowest point is reached if there should be additional lowering of six or eight inches it will mean the exposure of our dock tiling which is exposed to rotting and decay, and it will mean additional dredging. We aim to maintain a certain depth. If then the average level is reduced six inches our river dredging will have to be increased six inches in order to maintain the average depth. We hold that under the ordinances of 1787 the waters of the Great Lakes are dedicated to navigation and we protest against any diversion of water that will in the slightest degree affect the natural levels of the lakes and thereby affect our rivers and harbors.

Statement of George H. Eichelberger.

Representing Cleveland Chamber of Commerce.

"Mr. Secretary, I doubt whether anybody else here will desire to speak in behalf of the other cities in the Cleveland district, that is, Toledo, Lorain, Ashtabula, and Fairport Harbor, but the sentiment with regard to them along the south shore of Lake Erie is the same as with regard to Cleveland, and there is no difference between that and the situation at Milwaukee.

I want to call attention to two paragraphs which perhaps were overlooked, in the report of 1907, Second Division, page 14, Note N, at the bottom of the page:

> (n) The diversion of 10,000 cubic feet per second will lower the levels of Lake Michigan Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence River, be-

sides the important connecting channels, the Detroit and St. Clair rivers, by amounts varying from 4¼ to 6¼ inches for the different waters, and the diversion of 14,000 cubic feet will lower them from 6 to 8¼ inches. The diversion of 20,000 cubic feet will lower Lake Michigan-Huron about 13 inches and Lake Erie about 11 inches.

Secretary Stimson: Is that true of Cleveland?

Mr. Eichelberger: That is true of Cleveland. There is no question but what there will be necessity and great hardship worked there, in fact, in the outer basin, behind this three or four million dollar breakwater, they have built will be this necessity for dredging. Lake Erie is not like the other lakes. At almost every harbor in Lake Erie today this would mean an obstruction to navigation. The situation at Toledo is about the same as at Cleveland.

Looking a little beyond this request at this time, I happen to be one of those persons who argued the matter before Secretary Taft three years ago, and Mr. Littleton made the argument. They were then asking for 14,000 cubic feet of water, and the report of the President of the Sanitary District I have before me. He says that it takes about 6,000 cubic feet a second to reverse the current in the Chicago river.

Secretary Stimson: How much does that say?

Mr. Eichelberger: 6,000 cubic feet.

Since that time they have continued to spend further money, so when these gentlemen get the 10,000 cubic feet, they will come back here and want an additional amount, with the continued growth of population.

I understood you to say, Mr. Secretary, that you did not care to go into the matter of sewage; but the reason that it becomes important is that the public health is to some extent paramount.

Secretary Stimson: It may be paramount to Congress, but not here.

Mr. Eichelberger: Yes. However, the proposition that the commerce of the lakes will be hurt by this additional diversion of water is not chimerical, it is working out in practice. At that time they claimed that the lakes were fed by a subterranean or supernatural source, and that the amount taken out had no relation to the depth of water stage. But it has been proved that that is not correct. War Department engineers can verify that very easily to you.

Statement of Mr. Arthur Sullivan, of Chicago.

Mr. Secretary, * * * I would like to add a word as a vessel owner and a man operating steamers in the City of Chicago. The local situation there is something extremely critical. Under the present flow of 4,000 cubic feet,—we presume it is 4,000 cubic feet a second—navigation in the river is carried on at great hazard. The center pier structures and the swift current make it extremely dangerous and we have suffered loss of property and loss of life in consequence of these hazardous conditions. So far as any increase of the current goes, I should say it would mean disaster, and I am sure that so far as our ships are concerned we would not be able to operate them in the Chicago river.

I do not want to appear as antagonistic to the Sanitary District, only in respect of the increasing of the flow so that it will make it impossible for us to navigate our boats. * * *

The current in the river in the Chicago River at present is extremely detrimental to the safe handling of boats, and any increase in the velocity of the current would mean disaster. It would simply close Chicago as a port against any of the so-called modern ships, and to a large number of the vessels of an extremely smaller size.

Statement of Fred E. Signer.

Mr. Secretary, I represent the Association of Lake Lines. It is an association made up of package carriers. As package carriers we are more interested in the harbor conditions at the different ports than some of the other interests that have spoken before me (and) are interested in the Great Lakes as a whole. That is, you take the rail facilities and the crowded conditions at each one of the ports. That situation is creating more and more a demand for direct delivery by the boats to the industries along the lakes at the different ports, at which we operate to and from.

I judged that the navigation feature is the one which would be considered paramount here, and I had hoped to get two or three of our captains whose testimony I thought you would appreciate, coming from men who actually handle the boats and could tell you definitely and distinctly the hardships and the troubles they are having at the present time in navigating the Chicago River, and if an increased flow was allowed it would increase their trouble and possibly eventually drive us

out from making any direct deliveries in the Chicago Harbor. If the increased flow makes a reduction in the level, it will reduce the level in the harbors of the other ports we enter, and a corresponding situation will prevail, and from a commercial standpoint, the line of boats running between the Chicago River and the Milwaukee Harbor and to the other harbors which we operate to, it seems to me would match up considerably in excess of any of the commercial conditions that appear to be involved in this demand for an increased flow in the Chicago River.

Statement of Mr. H. B. Ford of Chicago.

Mr. Secretary, I am agent of the Union Steamboat Line. I am here to represent the Lake Lines Association at Chicago, in which are representatives, at Chicago, of what are known as the package freight lines, running from Lake Erie to Lake Michigan, and vice versa, and also to represent other marine interests.

The Lake Line Agents' Association is one of the associations I represent, and that association has from 25 to 30 steamers, carrying from 1,800 to 4,500 tons of package freight, and these from 25 to 30 steamers visit Chicago at least twice a month, and some of the fast ones that go straight through, three times a month. In other words, they are there every 10 or 11 days.

The Sanitary District of Chicago handles the current in the south branch and the main river as they see fit, without any notice to the marine interests or anyone else as to what the speed is going to be, and it interferes seriously with the free navigation of the South Branch. Our captains complain bitterly to the agents, particularly at night, of the speed of the current. Some of them have made the remark that if (it) had not been for the tug necessary to take them around the bends they could have come to their landing without using any steam.

When the Sanitary District opened the canal, they agreed with the Board of Trade to send every morning about 10 o'clock a notice to the Board of Trade as to what the current was to be for the next 24 hours. They did that for about 60 days, that information was posted on a blackboard. But after about 60 days it ceased, and has not been renewed. We have tried several times to find out why, but we have been answered indefinitely. We have made up our minds—and

when I say "we marine men," it was better for the marine men not to know what they were going to do.

Some of our captains find it impossible at certain times to leave our docks when they are bound south, or less than one-third loaded, when they cannot get a tug to help them, on account of the rapidity of the current. It is not safe to navigate a boat over 200 feet long in the south branch, which is only 200 feet wide in its widest part, and filled with pier structures between Lake street and Van Buren street. A boat bound in or bound out, drawing in the neighborhod of 17 foot, six inches, frequently goes across the river. If she is bound south she is going with the current and asks for the bridge and does not get it for some reason, and she has to back and when she backs it has a tendency to throw her stern to the port on the left hand and her bow to the starboard on the right hand. The current then catches her and until she strikes a bridge protection and gets across the river, she is going back. Then her stern is on this bridge protection, and it is very hard to get her to move along. We sometimes cannot do it even with three tugs, and the aid of a steam windlass, and then there is only one thing more for us to do, and that is that we apply to the Sanitary District, stating the facts, and asking them to shut off the current. That is the only way the boat can be relieved.

Secretary Stimson: Have you had to do that?

Mr. Ford: Yes, we did it three times last year, so I am told. None of our boats, but three others. When the boat is across the river that way she makes a dam, with just a little water going around her stern and her bow, and she may remain in that position for five or six hours—because it takes that long after they shut the dam at Lockport for the water to set back—and the water will be anywhere from eight to ten inches higher on one side of her than the other. Sometimes they will say, "All right, we will shut it off," when we apply to them, but more times they say, "Oh, no, we can't shut off the water now." We ask them when they can shut it off, and they probably name a time five or six hours later. And then we ask them why they cannot shut it off before then and they say, "It will interfere with our power contract we have, and our contract with the trolley company and the water works down there."

There is a report by one of the best engineers in the west that knows all about sanitation, sewage, and so forth, and my recollection is that his statement is that only 1,000 cubic feet of water is needed for Chicago to handle her sewage, that

what that will not dilute will be taken care of in some other manner. A thousand cubic feet will not interfere with navigation, with or without the current.

I have never seen a copy of that report. I have tried to get it in order to let you know the gentleman and his standing. Perhaps you can get a report, I cannot. That was Mr. George M. Wisner, the present Chief Engineer of the Sanitary District.

February 28, 1912.

MEMORANDUM FOR LAKE CARRIERS' ASSOCIATION.

To the Honorable Henry L. Stimson, Secretary of War:

1. The authority of the War Department in connection with public navigable waters is to preserve their integrity and guard against unreasonable obstruction in their free public use. The proponents furnish no basis of authority in the department for trading off, as it were, such public use in the interest of some other use of the waters, which seems the proposition involved in the application.

2. Therefore, while no one will question the necessary use for domestic purposes, nevertheless, this use is one which the department under authority to conserve navigable waters would not be expected to deal with.

3. Further, it is not denied that a reason for, or office of, the Sanitary Canal is to furnish power; and while it is said that this is merely an application of the flow, it nevertheless appears that besides the general injury to the commerce of and dependent on the Great Lakes System, this has also interfered specifically, and does from time to time, materially and seriously interfere with the navigation of Chicago River.

4. It is apparent also that other communities could similarly use the water, and to an extent which might most profoundly affect the navigable capacity of the Great Lakes and their connecting waters, to serious detriment of the interests of the general public of this country and Canada.

5. A circumstance of importance, not to be overlooked in any view of the case, is that application is specifically made to care for territory south of 87th street, in the face of two reports of experts, the one beginning at page 29, and the other at page 39, in the report of the Chicago Drainage Canal of 1907, second edition, to the effect that when the Drainage

Canal was originally proposed, an alternative method at about the same cost, would care for that section as well as for all except the central district of Chicago, the second report referred to strongly confirming the first mentioned.

6. Filtration plants are used in many of the principal cities of the world. We understand there is one in Washington. High authority exists for the proposition that it is not necessary to deplete the lake for such purpose, since under the alternative method, the water taken from the lake can be returned, less a small percentage of wastage, is practically unpolluted condition.

7. The point was suggested that inquiry should be narrowed to the sole question of the effect of taking out the additional flow. We submit that the question is broader; that it is artificial, narrow argument that having authority to remove one quantity, the question of injury to navigation be confined exclusively to the effect of removing the additional quantity without regard to the previous flow; but that is the old question of running the gauntlet, and that every additional subtraction must be treated in logic and in morals, with reference to the cumulated total flow.

8. There remains one other point introductory to the principal point of the effect on lake levels and navigation requirements. It has been suggested that because there are variations, through cycles of time, and from local, barometrical forces; and because these have to be met, therefore, a permanent reduction of the leval of half a foot, or a foot, or even more, may not be complained of. This we think sophistical and without merit. The same conditions and effects may be expected with the levels definitely and permanently reduced, with the permanently reduced base of level with which to reckon.

Heeding the admonition of the Honorable Secretary, that the question of interest here is the effect of reducing lake levels:

Precise figures may not be obtained, but the following has been computed by the President on full inquiry, and we submit as substantially correct.

It is found in active practice that the diminished carrying capacity of the largest bulk freighters upon the Great Lakes has been as much as 113 tons per inch of reduced loading depth per single one-way trip. This graduated to the smallest vessels in the bulk freight trade would, upon a very conservative basis, average 75 tons per inch per one-way trip;

150 tons per inch per round trip, if loaded both ways, as they frequently are; or, for six inches of diminished draft, approximately 450 tons each way, 900 tons per round trip. In normal seasons the vessels engaged in the bulk freight traffic make from twenty to twenty-five round trips; say twenty round trips, invariably loaded one way, frequently each way, and at 900 tons each would mean a loss of 18,000 tons per vessel for a season, and so for 400 vessels an approximate loss of 7,200,000 tons; and so with freight rates averaging forty cents per ton net, the loss to the vessels would therefore aggregate approximately $2,880,000 in a single season, which, capitalized at five per cent., amounts to $57,600,000; or, at a diminished draft of eight inches, cumputed in the same manner, the results would show approximately 600 tons one way, 1,200 tons per round trip, amounting, for 400 boats, averaging 20 trips each, and loaded both ways, with same freight rate, to $3,840,000, which, capitalized at five per cent., amounts to $76,800,000.

As a matter of fact, the average ore cargo during the season of 1911, as computed for the Annual Report, was 7,178 tons as against 8,325 tons in 1908, a loss of 1,147 tons per trip one way.

* * * * *

It was hoped to append statement showing the expenditures by the various ports on the shores of the Great Lakes, on both sides of the border, in the improvement of their respective harbors. There has been but partial success in securing this character of information in the limited time from the various municipalities, so that a list is not attempted. We cannot forbear stating, however, that an Engineer Officer of Cleveland gives the amount since 1870 expended at Cleveland as $6,143,591.92, including interest charges, and at Buffalo we are informed that such expenditures have been $4,880,149.02; figures indicative of the importance in which Lake Commerce is viewed by municipalities upon the shores of the Great Lakes. Also, we have taken from the Annual Report of the Chief of Engineers for the fiscal year ending June 30th, 1911, and for convenience group these itemized by ports, aggregating $105,461,130.60, a statement of which is appended. We assume that there will necessarily be before the Honorable Secretary the report of the Special Commission of U. S. Engineers,—of which General Bixby was Chairman, submitted to Congress February 9th, 1911; but we call attention to the language also of the Board of Engineers, in

their report in this connection, in which they emphasize the point, saying, "And, further, until the interests of the United States shall be satisfactorily safeguarded, as indicated by the Special Board, namely, that the State of Illinois, or its agency, shall assume entire responsibility in perpetuity for all damages by changes in lake levels incident to the work," the work be not undertaken, etc.

We have shown the increase in size of ships, and the effect of reduction. It remains in conclusion to say that it is essentially incorrect to consider all this as a question between the vessel owner as such and the Sanitary District. The vessel owner made a higher rate on his investment, with less effort when ships were smaller. He has built his ships, not only on the lakes, but throughout the world, larger and larger, because of the demands of commerce. The capacity of the ship and the facility and dispatch with which she is handled in port, controls the rate of freight, and the demands of trade and commerce regulate the whole. Therefore, it is the obvious advantage and necessity in every center of commerce, to meet the demands for cheapest and best transportation. It is for this reason that vessels have increased in size, and in recognition of the general demand, some of the strictures in our great system of waterways have been removed, and channels have been enlarged, the port facilities have been increased, breakwaters built by the Government, harbors dredged at local expense, and many millions of dollars invested in terminal facilities, not for any mere accommodation of the ship, but to meet the general demands of trade, which it is well understood, has for one of its prime, and doubtless its most important factor, cheap and efficient transportation. Anything which interferes with or abridges this, or retards its development, takes on the proportions of a public misfortune.

We cannot close more appropriately than by referring to the paper read by Sir William Henry White, at the meeting of the Society of Naval Architects and Marine Engineers, in New York, November 16th, 1911, in which this most eminent authority discussed the increase in size and capacity of ships, the necessity for corresponding increase in channels and in the ease and facility for moving the ships in port, and of handling their cargoes within some permissible time related to the expense of upkeep and operation of the ships. We may briefly quote:

"For each class the average size of ship has been increased, and the fact is apparent in every statistical 'Return' of the

movements of shipping. In 1860 the average gross tonnage of ships (exceeding 100 tons) on the Register of British shipping was 340 tons; in 1870, 580 tons; in 1880, 1,250 tons; in 1890, 1,570 tons; in 1902, 2,200 tons." (These are registered tons, not carrying capacity.) "Since the Suez Canal was opened, the average size of vessels passing through it has grown steadily; the same may be said of the vessels passing through the Sault Sainte Marie Canal."

Again he says: "Up to the present time the response made to the appeals from ship owners for increased accommodations for ships by authority of the great seaports of the world, has been neither niggardly nor unsatisfactory. At the present moment extensive and costly works are in progress which will provide accommodations for the largest ships now building, and leave some margin for further development. * * * Immense sums are being expended on improvements and extensions of docks and harbors, as well as on the approaches thereto, both by governments and by proprietary bodies." He mentions as one of the latest the project for making the dock and channel accommodations of the port of London suitable for the existing trade and for providing a proper margin to meet future developments at an estimated cost of over $72,000,000. And again on this subject: "The advantages to be obtained by the whole community, and not the profit of a particular section, ought and will determine what is done eventually."

So as to the benefit of Lake transportation to the country at large, official statistics are not lacking to show saving in a single season, over any other method of conveyance equal, if not exceeding, the entire expenditures of the Government from the beginning in Lake Improvements.

March 29, 1912.

Respectfully submitted,

(Sgd.) Harvey D. Goulder,
Counsel.

(Sgd.) William Livingstone,
President.

AMOUNT OF EXPENDITURE BY U. S. GOVERNMENT ON IMPROVEMENT AND MAINTENANCE OF HARBORS AND CHANNELS OF GREAT LAKES TO JUNE 30, 1911, AS SHOWN BY REPORT OF CHIEF OF ENGINEERS, U. S. A., FOR FISCAL YEAR ENDING JUNE 30, 1911.

Project	Improvement	Maintenance	Total
Grand Marais, Minn.	$ 110,936.68	$ 5,390.40	$ 116,327.17
Agate Bay, Minn.	234,057.53	21,419.34	255,476.87
Duluth-Superior	5,917,194.15	556,030.00	6,473,224.15
Port Wing, Wis.	41,301.95	11,025.30	52,327.25
Ashland, Wis.	198,017.28	293,207.76	491,225.04
Ontonagon, Mich.	284,801.24	113,718.53	398,519.77
Keweenaw Waterway	1,057,127.72	281,303.67	1,338,431.39
Marquette, Mich.	677,358.82	24,855.79	702,214.61
Marquette Harbor of Refuge	55,056.34	2,701.82	57,758.16
Grand Marais Harbor of Refuge	355,885.29	130,326.49	486,211.78
Manistique, Mich.	79,132.62	....	79,132.62
Gladstone, Mich.	7,280.59	252.17	7,532.76
Menominee, Mich.	387,010.61	24,831.10	411,841.71
Oconto, Wis.	93,462.65	....	93,462.65
Green Bay, Wis.	508,284.90	49,667.84	557,952.74
Depere, Wis.	7,418.22	....	7,418.22
Sturgeon Bay and L. M. Canal and Harbor of Refuge	590,336.71	19,125.69	609,462.40
Algoma, Wis.	293,832.95	24,384.20	318,217.15
Kewaunee, Wis.	149,999.99	49,753.32	199,753.31
Two Rivers, Wis.	301,172.75	29,162.87	330,335.62
Manitowoc, Wis.	688,915.18	209,832.37	898,747.55
Sheboygan, Wis.	603,989.75	29,176.12	633,165.87
Port Washington, Wis.	226,133.09	7,435.40	233,568.49
Milwaukee, Wis.	1,844,889.86	507,701.79	2,352,591.65
Racine, Wis.	549,337.91	36,583.02	585,920.93
Kenosha, Wis.	506,238.40	24,842.26	531,080.66
Waukegan, Ill.	529,283.80	121,656.13	650,939.93
Fox River, Wis.	3,847,542.55	....	3,847,542.55
Chicago Harbor, Ill.	2,431,921.04	131,513.43	2,563,434.47
Chicago River, Ill.	1,349,770.02	113,365.18	1,463,135.20
Calumet Harbor, Ill.	1,431,278.15	57,750.29	1,489,028.44
Calumet River, Ill.	1,072,501.56	45,230.48	1,117,732.04
Indiana Harbor, Ind.	1,405.59	....	1,405.59
Michigan City, Ind.	1,401,043.63	320,824.22	1,721,867.85
St. Joseph, Mich.	806,206.61	79,836.66	886,043.27
St. Joseph River, Mich.	4,555.49	1,707.84	6,263.33
South Haven, Mich.	190,269.93	183,421.40	373,691.33
Saugatuck Harbor and Kalamasoo River	323,796.47	168,142.58	491,939.05
Holland, Mich.	491,627.79	253,977.21	745,605.00
Grand Haven, Mich.	542,976.82	420,573.06	963,549.[illegible]
Grand River, Mich.	385,201.08	56,883.63	442,0[illegible]4.71
Muskegon, Mich.	556,195.86	244,797.26	800,993.12
White Lake Harbor	207,862.44	153,439.72	361,302.16
Pentwater Harbor	179,899.10	148,642.47	328,541.57
Ludington	1,173,437.61	147,451.12	1,320,888.73
Manistee	330,160.80	143,571.52	473,732.32
Portage Lake (Manistee Co.)	254,129.21	130,807.59	384,936.80
Arcadia Harbor	....	15,042.46	15,042.46
Frankfort	331,727.18	138,433.21	470,160.39
Charlevoix	80,205.04	129,[illegible].66	216,199.63

Project	Improvement	Maintenance	Total
Petoskey	$ 118,239.40	$ 7,532.05	$ 125,771.45
Ship Channel between Chicago, Duluth and Buffalo	3,340,000.00	....	3,340,000.00
St. Marys Falls	9,141,572.08	....	9,141,572.08
Hay Lake and Middle Neebish	8,312,673.61	....	8,312,673.61
Mackinac Harbor	5,457.87	....	5,457.87
Cheboygan	190,310.69	....	190,310.69
Rogers City, Mich	36.38	....	36.38
Alpena	35,798.69	15,290.65	51,089 34
Saginaw River	971,978 28	....	971,978.28
Sebewaing River	79,146.45	8,419.22	87,565.67
Harbor Beach	975,000.00	952,002.32	1,927,002.32
Black River (Monroe, Mich.)	85,848.58	12,008.31	97,856.89
Rouge River	80,355.28	26,270.18	106,625.46
Monroe Harbor	261,344.51	....	261,344.51
Black River (Port Huron)	56,934.09	....	56,934.09
St. Clair Flats Canal	....	9,451.34	9,451.34
Clinton River, Mich	54,829.79	....	54,829.79
Detroit River	9,687,829.99	....	9,687,829.99
Toledo Harbor	2,457,667.79	186,827.56	2,644,495.35
Port Clinton, Ohio	105,209.29	1,933.70	107,142.99
Sandusky	1,121,819.73	40,004.76	1,161,824.49
Huron	461,111.32	70,219.66	531,330.98
Vermilion	164,779.57	....	164,779.57
Lorain	943,162.82	36,066.61	979,229.43
Cleveland	6,105,284.06	532,346.78	6,637,630.84
Fairport	824,460.85	127,819.59	952,280.44
Ashtabula	1,361,330.19	29,676.87	1,391,007.06
Conneaut	909,031.43	50,399.32	959,430.75
Erie	1,446,160.42	....	1,446,160.42
Dunkirk	987,846.56	....	987,846.56
Buffalo	5,728,663.38	....	5,728,663.38
Black Rock	2,303,717.30	....	2,303,717.30
Tonawanda Harbor and Niagara River	661,671.45	....	661,671.45
Niagara River	60,135.30	....	60,135.30
Olcott	177,986.87	....	177,986.87
Charlotte	765,124.14	....	765,124.14
Puttneyville	70,607.96	12,657.19	83,265.15
Great Sodus Bay	408,329.80	142,100.89	550,430.69
Little Sodus Bay	301,398.21	168,872.55	470,270.76
Oswego	2,383,438.40	....	2,383,438.40
Cape Vincent	129,473.84	389.80	129,863.64
Ogdensburg	272,602.83	130,512.32	403,115.15
Total	$ 97,240,540.15	$ 8,220,590.45	$ 105,461,130.60

BRIEF ON BEHALF OF THE CLEVELAND CHAMBER OF COMMERCE.

Mr. Secretary:—

The Cleveland Chamber of Commerce comes to you representing the commercial interests and reflecting the sentiments not only of the people of Cleveland, but, indirectly, it represents far more than that, because the interest taken by the Cleveland Chamber of Commerce is, from the relation of Cleveland to the commerce of the Great Lakes, extended to include all of the lake cities and the vast shipping interests of the Great Lakes; because whatever subtraction of water would affect Cleveland, would be proportionately disastrous to all the Lake Erie ports from Toledo to Buffalo, as well as to those points along the south shore of Lake Erie which are rich in possibilities as shipping centers, but whose resources are as yet undeveloped.

And it is to inquire into the reasonableness of the request of the Sanitary District of Chicago, taking into consideration all of the interests involved, that we come before you.

We believe it needless to urge upon your consideration the report of the Chicago Drainage Canal by the International Waterways Commission dated Toronto, Ontario, January 4th, 1907, wherein a careful and exhaustive consideration is given to the subject in many of its phases, the conclusions of which are characterized by a fairness that should be obvious to all.

The people of the northwest territory find the outlet of the Great Lakes diverted by their natural watershed through the St. Lawrence River to the sea. Settlements from which sprang cities grew up along the shores of these great bodies of water and their development gave rise to great maritime interests. The Government of the United States assumed control over these waters, and has from time to time appropriated large sums towards improving their ports and the natural channels whereby commerce could be facilitated. Our present generation come into the great legacy of the benefits conferred by these waters, and it should be our aim to pass them on to the next generation without diminution of bulk or usefulness; or rather, we should strive to continue their development and enlarge their field of usefulness in all respects consistent with the general welfare. And it is in this view of the case that the request of the Sanitary District should be considered.

* * * * * * *

We must recognize that the diversion of water for sewage purposes through the Chicago River is an accomplished fact;

that engineers generally have insisted that it was the only means by which the central district of Chicago so drained could dispose of its sewage, and that vast sums of money have been spent in accomplishing this end. The readiness with which the plea of money already expended was urged at the hearing as a reason why more water should be permitted shows how the same plea will be made as the years go by with constantly increasing effect. Money expended now in providing for an additional flow through the Chicago River will, in a measure, be money lost if any other means of sewage disposal is attempted in the near future. The fact, therefore, that another method of sewage disposal is possible, and at but a comparatively slightly greater expense, and the fact that the demands for the Chicago River must constantly increase with the growth of population, are strong reasons why there should be no enlargement of the project while alternative means are available; certainly not until it could be conclusively shown that alternative means are inadequate, and the effect upon lake levels is exactly proven. If the effect will be as the reports now in your hands indicate, then there should be no permit granted of the kind now asked.

The contention that the withdrawal of this great volume of water from the lake would not deplete them, basing this conclusion upon the variation of lake levels due to wind and rainfall does not seem to demand serious consideration. However enormous the lakes may appear they must be considered as reservoirs and the quantity of water held in them to be subject to natural laws.

That the subtraction of water has resulted in the lowering of lake levels is rather conclusively indicated by the facts furnished by General Bixby showing lake levels for the year 1911. He states that during the past four years Lake Superior has dropped about 0.8 feet, thereby losing in storage capacity more than four months' total discharge; Lakes Michigan, Huron and Erie in the past two years have each dropped about 0.8 feet; and Lake Ontario in two years has dropped about 1.5 feet. On all the lakes the present water surface is at least 0.5 feet below the average for the past 51 years. The Lake Survey records for 1911 indicate that all the lakes are continuing their rapid drop in level.

We think that the inference is perfectly fair, that this lowering of lake levels is due, in part at least, to the depletion of the waters of Lake Michigan by the drainage canal, and

has verified the predictions of the engineering corps previously referred to.

We beg, therefore, to enter our protest against the War Department permitting any additional flow of water through the drainage canal by granting the permit requested, and would beg to be allowed to go further and ask that the War Department take steps to determine whether the Sanitary District is at present exceeding the quantity previously authorized, and if it is found that this be true, that the excessive quantity be prohibited.

In view of the foregoing it hardly seems necessary to deal with the several questions which were presented at the hearing before the Department on February 27th-28th, 1912. But, following the lines of argument, we wish to call your attention,

First, As to the right of the War Department to grant the permit asked for without Congressional action. We think a distinction should be drawn between an essential executive act and a question of broad, far reaching policy.

Second, Should your Department under the present treaty relations between the United States and Great Britain allow such action if it can be shown that from such permission material and irreparable damage will be done to the interests of the British Dominion of Canada;

Third, Does it not follow that the Honorable Secretary of War, as was suggested at the hearing, in the performance of his official duty confine his attention to the one question of whether this depletion would not injuriously affect commerce through its effect on the navigability of the Great Lakes;

Fourth, Is not the subject one of such broad, general significance as to involve the future policy of the Government with regard to the uses and diversions which may be made of the waters of the Great Lakes, and, therefore, is not the Drainage Board going too far to ask an administrative arm of the Government to determine the questions involved without Congressional authorization?

Respectfully submitted,

(Sgd.) George H. Eichelberger.
(Sgd.) Harvey D. Goulder.

Extracts from proceedings before the Secretary of War in regard to the application of the Sanitary District for permission to divert not to exceed 10,000 cubic feet of water per second through the Chicago and Calumet Rivers. A hearing was given on March 27, 1912, to representatives of the Canadian Government and Canadian interests.

Appearances:

Mr. Daniel Mullin, K. C.,
Counsel.
Mr. A. St. Laurent,
Assistant Deputy Minister, Department of Public Works, Canada.
Mr. W. J. Stewart,
Chief Hydrographer.
Mr. V. W. Forneret,
Supt. Engineer, St. Lawrence Ship Channel.
Mr. John Kennedy,
Consulting Engineer.
Representing the Government of the Dominion of Canada.
Mr. James White,
Secretary, and
Mr. A. V. White,
Engineer, representing the Canadian Commission of Conservation.
Mr. David Seath,
Secretary, representing the Montreal Harbor Commission.
Mr. F. S. Spence,
Acting Chairman, and
Mr. E. L. Cousins,
Chief Engineer, representing the Toronto Harbor Commission.
Mr. R. W. Reford,
President, and
Mr. L. Henderson,
Chairman of Harbor and Navigation Committee, representing the Montreal Board of Trade.
Mr. Andrew Allan,
President, and
Mr. Thomas Robb,
Secretary, representing the Shipping Federation of Canada.

Mr. F. E. Meredith, K. C.,
Counsel representing the Shipping Federation of Canada, and representing the Canadian Pacific Atlantic Steamship Lines, and the Canadian Northern Atlantic Shipping Line.

Mr. J. V. O'Donahoe,
Assistant General Manager, representing the Richelieu and Ontario Navigation Company.

Mr. Francis King,
Counsel representing the Dominion Marine Association.

Mr. G. T. Blackstock, K. C.,
Counsel, and

Mr. D. H. MacDougall,
Secretary, representing the Toronto Power Company.

Brief Submitted on Behalf of the Government of Canada in Opposition to the Above Application.

The proposed diversion so far as it affects navigation not only upon boundary waters but also upon the waters of Lake Michigan and the St. Lawrence river, from the point where it ceases to be a boundary water, as well as the canal system, presents serious objections from the Canadian standpoint to the granting of the permit asked for.

First, dealing with the legal aspect of the case, it must be borne in mind that, by the terms of the second clause of Article I of the International Boundary Waters Treaty, it is "agreed that so long as this Treaty shall remain in force, the same right of navigation shall extend to the waters of Lake Michigan and to all canals connecting boundary waters, and now existing or which may hereafter be constructed on either side of the line," as is given by the first clause of that Article with respect to boundary waters, that is to say, "that the navigation of all navigable boundary waters shall forever continue free and open for the purposes of commerce to the inhabitants and to the ships, vessels and boats of both countries equally, subject, however, to any laws and regulations of either country, within its own territory, not inconsistent with such privilege of free navigation and applying equally and without discrimination to the inhabitants, ships, vessels, and boats of both countries."

It will thus, be seen that the second clause of Article I secures to Canada free and unobstructed navigation of the

waters of Lake Michigan from which the proposed diversion is to be made. In other words, it secures to Canada, in express terms, the right to navigate those waters in any manner which the natural flow will permit. It is submitted, therefore, that any interference with the natural flow which decreases the navigable capacity of Lake Michigan or renders its navigation difficult in any way, is an infringement of the letter and spirit of the treaty.

The right to navigate necessarily implies that vessels of both countries plying on Lake Michigan shall be entitled to make all harbours including Chicago, without being subjected to perils not ordinarily incident to the navigation of Lake Michigan. It has been shown, by reason of the diversion of 4,167 c.f.s. now existing, the current in the Chicago river is of such velocity as to render it extremely detrimental to the safe handling of vessels, and any increase in the volume of the diversion would be fraught with disaster to vessels using the port of Chicago. The testimony of those representing these interests is to the effect that the diversion already existing renders the navigation of vessels, bound to and from the port of Chicago, extremely hazardous having, it is said already caused loss of life and property by reason of the swift current arising from such diversion. A large number of vessels are engaged in the carrying trade between Chicago and Canadian ports, chiefly laden with grain outward from Chicago, and these vessels while plying to and from this latter port are exposed to perils by the extreme current caused by the diversion of the waters of Lake Michigan through the Chicago river, a danger which will become greatly augmented if the increased flow asked for is permitted.

The diversions for power purposes at Niagara Falls on either side of the line are not analogous as they do not affect navigation, the water taken being returned again and the levels in the navigable portions are not lowered. But, the diversion at Chicago from which there is no return, on the other hand, means an absolute and permanent lowering of the levels of the Great Lakes system from Sault Ste. Marie to the head of the tide at Lake St. Peter on the St. Lawrence river. It is of the highest importance that the Great Lakes system on the boundary between the United States and Canada and finding its outlet by the St. Lawrence to the sea, so vital to the prosperity of the great interior sections of both countries, should be maintained in its integrity.

It is significant, that while the framers of the International

Boundary Waters Treaty, basing their work on that of the International Waterways Commission, accepted the latter's suggestion as to the diversion on the Canadian side at Niagara Falls, and increased the amount to be diverted on the United States side to 20,000 c.f.s., they evidently ignored the Chicago Drainage canal regarding which the Waterways Commission had suggested that the diversion should be limited to 10,000 c.f.s. The fair inference is that neither country agreed to the recommendation of the Waterways Commission that the diversion from Lake Michigan to the Chicago Drainage canal should not exceed 10,000 c.f.s. At all events in the absence of any mention of the Chicago Drainage canal in the Treaty, it is contended that Canada never agreed to the proposed diversion of 10,000 c.f.s. The spirit of the treaty indicates that the levels of boundary waters on one side are not to be disturbed by works or diversions on the other without proper approval.

It will be observed that by the second clause of Article II of the Treaty, it is declared "that neither of the high contracting parties intends by the foregoing provision [clause 1 of Article II, reserving exclusive jurisdiction and control over the use and diversion of all waters on its own side of the line which, in their natural channels, would flow across the boundary or into boundary waters] to surrender any right which it may have to object to any interference with, or diversions of, waters on the other side of the boundary the effect of which would be productive of material injury to the navigation interests on its own side of the boundary." This second paragraph of Article II expressly opens the door to Canada to object to any diversion of waters of Lake Michigan to the Chicago Drainage canal so far as such diversion would be productive of material injury to the navigation interests on the Canadian side of the boundary.

Article III dealing with "boundary waters" provides that in addition to the uses, obstructions and diversions heretofore permitted "no further or other uses or obstructions or diversions whether temporary or permanent of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side . . . . shall be made except by *authority of the United States or Dominion of Canada,* within their respective jurisdictions *and with the approval*" *of the International Joint Commission.* The final clause, after stating that the foregoing does not limit the right of either country to carry on dredging for the deepen-

ing of the channels within their own territory, provided the level or flow of water on the other side is not *materially* affected, closes as follows: "nor are such provisions intended to interfere with the *ordinary* use of such [boundary] waters for domestic and sanitary purposes."

Bearing in mind the scope and object of the treaty, embracing, as it does, the conservation of boundary waters and the maintenance of lake levels, any diversion from their natural channels of waters on either side of the boundary which materially affects the levels of boundary waters, is a violation of the spirit, if not the letter, of the treaty.

In this connection a very grave question arises as to whether the Chicago Drainage canal is not a matter which might properly be referred to the International Joint Commission under the treaty, but, without insisting on that course at the present time, Canada expressly reserves the right to raise the question at a subsequent stage if it should be deemed expedient to adopt that attitude.

Another consideration which, it is submitted, ought not to be lost sight of is, that the diversion of 10,000 c.f.s. proposed for the Chicago Drainage canal is not an "ordinary use" for sanitary purposes, but an extraordinary use, unprecedented in its magnitude and unparallel in its method of abstracting and not returning the water after using it for sanitary purposes, whereas the Treaty contemplates "only *ordinary use* for domestic and *sanitary* purposes."

Then again, as the United States Government Engineers consider 1,000 c.f.s.—10 per cent. of the Sanitary District's application—sufficient for navigation, the question arises: is the balance of 9,000 c.f.s. necessary for the "ordinary use" of sanitation purposes. It is submitted that the diversion of such an immense quantity of water for sanitary purposes is not an "ordinary use" when it is remembered that it is a solitary and isolated instance of such user. If Chicago is to demand large bodies of water for diluting sewage, its demands on Lake Michigan will depend on its continued growth, and other cities and towns—following the precedent of Chicago—will be just as much entitled to adopt similar dilution methods for treating sewage by the abstraction of large quantities of water, if they find such a course practicable, with disastrous results to the Great Lakes waterways system.

Referring to the diversion of water through the Chicago Drainage canal, the report of a special Board of Engineers, which is signed by General W. H. Bixby, Chief of Engineers, United States Army, dated January 23, 1911, at pp. 8-9 says:

"For purposes of navigation a diversion from Lake Michigan of less than 1,000 second-feet of water is all that will be necessary. For purposes of sanitation the works of the Sanitary District of Chicago were designed to allow the diversion of 10,000 second-feet and now contemplate a total of 14,000 second-feet, the additional 4,000 second-feet to be obtained by the diversion of water through the Calumet River and a connecting canal following the Sag route. The War Department, while awaiting the definite action of Congress, has so far permitted the diversion of 4,167 second-feet, and the Sanitary District is understood to be using about 7,000 second-feet. As the water which is at present being diverted from the lake appears to have already seriously affected the navigation of its harbors and connecting waterways, prompt Congressional action is recommended to limit the diversion.

"While it appears to have been assumed that the Sanitary District may be allowed to divert 10,000 second-feet so long as actually necessary for sanitary purposes, the diversion of the waters of the Great Lakes from their natural outlet for power development alone is inadmissible under the recent treaty between the United States and Great Britain. The future diversion of water from Lake Michigan for any purpose is fraught with difficulties. Not only has Canada an interest in the maintenance of lake levels which the United States must recognize, but every foot of water flowing through the Chicago Drainage canal lessens the flow at Niagara Falls and at the power sites along the St. Lawrence river, where, due to the fall available, the same amount of water will create about four times the power that can be generated from it on the Des Plaines and Illinois rivers. The treaty enables riparian owners of Canada, as well as of the United States, who consider themselves injured by such diversion, to bring suit in United States courts to protect their interests. The claim that more than 1,000 cubic feet per second is required for purposes of navigation cannot be maintained. The treaty, however, recognizes as proper the use of water for sanitary purposes, and it is the opinion of the Board that only such water should be diverted from Lake Michigan as is indispensable for sanitation, and then only with a provision for proper compensating works in the outlets of the lakes to prevent a lowering of their levels. Water thus diverted may be used incidentally for power purposes, but care must be exercised in authorzing the diversion of water for sanitary purposes to restrict it to the amount necessary for those purposes alone."

Extract from Appendix E, attached to the Chicago Harbour Commission Report (1909), where General W. H. Bixby, at page 313, says:

"There is another feature, while I am on the harbourage of Chicago—the Chicago river affects the entire Great Lakes system. The interests of all other harbours on the Great Lakes are entitled to a great deal of consideration in anything that is done in the Chicago river."

And, again, on the same page:

"The War Department holds every engineer in charge of districts responsible for protecting and safeguarding navigation needs of the general public. That includes the commerce on the Great Lakes that wants to come to Chicago, just as much as the commerce of Chicago itself that does not get outside Lake Michigan."

The report of the International Waterways Commission, dated January 4, 1907, at page 180, says

"The depth in the Welland canal and in the six canals employed to overcome rapids in the St. Lawrence river is now 14 feet, of which every inch is needed. At the head of the Cornwall canal in the St. Lawrence river the abstraction of 14,000 cubic feet of water per second at Chicago will lower the surface about 6¾ inches at mean level and much more at low water. To restore the depth in these canals involves the reconstruction of all the end locks and deepening the approaches thereto, and is estimated to cost $2,500,000.

"The total cost of restoring the depth in the harbours of the Great Lakes and the channels between the lakes is therefore roughly $10,000,000, and of restoring it in the Welland and St. Lawrence canals is $2,500,000 additional, or $12,500,000 in all.

"The shores of the Great Lakes are very far from being fully developed, and it is highly probable that many harbours not now in existence remain to be created, or, if in existence, remain to be improved. The lowering of the lakes' surfaces increases the difficulty and cost of such improvements. This consideration is of importance, although no money value can now be given it.

"The expenditure of the sums mentioned above will restore the depths now existing, but it will not prevent very serious annoyance to the navigation interests during the execution of the work. The time required will be several years, and in the meantime the vast commerce of the Great Lakes will be hampered, not only by deficient depth, but also by the

occupation of the channels, already crowded with commerce, by the excavating machines.

"It is evident from the foregoing that large bodies of water cannot be diverted by the Chicago Drainage canal without very serious detriment to the navigation interests of the Great Lakes and of the St. Lawrence valley. The greater the amount of water diverted the greater the injury. Chicago being one of the principal lake ports, there will be very few communities which will feel this detriment more than she will.

"In the presence of these interests the effect upon Niagara falls may be simply mentioned with a reference to our former reports upon that subject. The volume of Niagara falls will be reduced by the full amount diverted at Chicago."

Again, the same report, at page 181, states:

"The Chicago Drainage canal having been constructed with a capacity, as it turns out, of 14,000 cubic feet per second, full power development will call for the whole of that amount, and, in fact, power works are now under construction at Lockport to utilize it. Inasmuch as the sanitary requirements by the standard, fixed in the state law, are only 6,667 cubic feet per second for the present population of 2,000,000, it is evident that power development, incidental though it be, does lead to demands for waters not required for sanitary purposes."

The same report, again, at page 184, says:

"The diversion of 10,000 cubic feet per second will lower the levels of Lake Michigan-Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence river, besides the important connecting channels, the Detroit and St. Clair rivers, by amounts varying from 4¼ to 6¼ inches for the different waters, and the diversion of 14,000 cubic feet will lower them from 6 to 8¼ inches. The diversion of 20,000 cubic feet will lower Lake Michigan-Huron about 13 inches and Lake Erie about 11 inches.

"The lake traffic which passed through the Detroit river in 1905, was about 58,000,000 tons, valued at about $615,000,000. It is increasing annually, with marvellous rapidity. The records for the year 1906, so far as they are made up, indicate that the number of tons which passed through the Detroit river in 1906, exceeded 65,000,000, valued at $690,000,000. The lowering of the water surface has a very injurious effect upon this traffic, and upon that of the Welland and St. Lawrence canals."

And, at page 211, it states:

"The extension to the Calumet region of the method of sew-

age disposal already applied to the Chicago river is not necessary to preserve the health of Chicago, there being other and better methods available for the Calumet region. The final cost of these methods is somewhat greater than that of the one proposed, but the works can be developed as the population increases, and only a part of their cost need be incurred at present, while their greater efficiency justifies the increase of final cost."

By Article XXVI of the Treaty of Washington, May 8, 1871, it was provided that "The navigation of the river St. Lawrence, ascending and descending from the 45th parallel of north latitude, where it ceases to form the boundary between the two countries, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain or of the Dominion of Canada not inconsistent with such privilege of free navigation." It is, therefore, apparent that the Government of the United States, equally with that of Canada, has a direct interest in protecting the navigation of the river St. Lawrence, as it appears that the free navigation of that river is open in perpetuity to citizens of the United States where it passes wholly through Canadian territory.

The State of Illinois, in response to the Treaty of Washington, (May 8, 1871), by Act of the General Assembly, approved April 4, 1872, granted "The use of the Illinois and Michigan canal, and all other canals that may be constructed by this State" to the citizens of the Dominion of Canada, on equal terms with citizens of the United States.

By treaties now in force, the Great Lakes waterways from Lake Superior to the sea, including all boundary waters as well as Lake Michigan in the United States, all connecting canals and the St. Lawrence river including that portion which flows wholly through Canadian territory, are open to the free navigation of both countries. The United States and Canada are equally concerned in maintaining unimpaired this great water highway for the benefit of the commerce of both countries.

In view of objections arising from the impossibility of preserving navigation unimpaired on the boundary waters, treaty rights covering such waters and the navigation of Lake Michigan and the St. Lawrence to the sea, international relations and comity as well as the impossibility of providing adequate compensation for injury to Canadian interests, both

public and private, it is nrged that the permit asked for, should not be granted.

That the proposed diversion will be productive of material injury to the navigation interests on the Canadian side of the boundary, there is abundant evidence, a statement of which has been prepared by technical officers from the Canadian Government Departments of Public Works, Naval Service, and Marine and Fisheries, also the Montreal Harbour Commission, as follows:

In the following memorandum it is proposed to show that a diversion of 10,000 c.f.s. at Chicago through the Drainage canal will lower the water of all the lakes below Sault Ste. Marie, as well as of the St. Lawrence river as far east as Lake St. Peter.

That it will entail heavy losses upon Canada for the restoration of the lost depths in harbours and channels in the Great Lakes and St. Lawrence river.

That Canada must expend large sums on her canal system to render it as useful as it was designed to be.

That it will cause heavy loss to the inland marine interests and to shipping below Montreal, by reducing the draft and carrying capacities of the vessels.

That much of this loss must be borne by the consumer.

That many outlying shoals will be more dangerous to navigation under the new conditions than at present.

That injury will be done to many owners of private wharves by reason of the depth of water at, and approaching them, being reduced.

That injury will be done to many wharves and breakwaters that have been constructed of concrete on wooden cribs, by reason of the wood becoming exposed to the air for long periods, allowing rot to set in and imperilling the superstructure.

That granting 10,000 c.f.s. for power means a huge waste of energy as the same amount of water would generate much more power by the other route.

That the diversion of any quantity of water from Lake Michigan will lower the levels of all the lakes below Superior, hardly requirés proof in these days, but the case may be stated briefly:

As the promoters and backers of the scheme assert, it is impossible to show on the lake shore, or on a gauge, the effect of a diversion. One cannot see, at the same time, the water level under natural conditions and under diversion but the

loss can be demonstrated as surely as any mathematical problem.

The following table will show the mean level of the lakes for 52 years and the lowest monthly mean.

Lakes	Mean of 52 Years		Lowest Monthly Mean
Huron-Michigan	581.35		578.98
Erie	572.59		570.70
Ontario	246.18		243.41
St. Lawrence R. (Rapide Plat)	224.8	(mean of 28 yrs.)	221.44
" (Head of Cornwall Canal)	201.07	" "	198.05

It is found by measurement and computation (see Report of International Waterways Commission on the Regulation of Lake Erie, p. 53), that the discharge of Lake Huron at Port Huron is 16,300 c.f.s. more when the lake surface has an elevation 580, than when it has one of 579; or, one foot of rise (near low water) means a difference in discharge of 16,300 c.f.s. Therefore, an increased discharge of 10,000 at or near low water means a lowering of 10,000/16,300 ft. or 7.4 inches.

If Lake Huron suffers a decrease in discharge of 10,000 c.f.s. at Port Huron, Lake Erie suffers a decrease in supply of the same amount which may be treated as an increase in discharge causing a loss of level. The same remark applies to Lake Ontario and the St. Lawrence river as far as tide water.

In Lake Erie the change in discharge for one foot change of level near low water, is 19,600 c.f.s. Therefore, an increase in discharge of 10,000 c.f.s. means a lowering of 10,000/19,600 ft. or 6.1 inches.

In Lake Ontario the change in discharge for one foot change of level near low water is 26,800 so that an increase in discharge of 10,000 c.f.s. means a lowering of 10,000/26,800 ft. or 4.5 inches.

At Rapide Plat, in the St. Lawrence river, the increment is 17,500 and the lowering is 6.8 inches.

At the head of the Cornwall canal the increment is 24,350 and the lowering 5 inches.

Loss of level on Lakes Huron, Erie, Ontario and the St. Lawrence river under the actual diversion and under assumed diversions of 10,000 and 14,000 c.f.s. through the Chicago Drainage canal:

Lake.	Loss of Level		
	Actual Diversion	Assumed Diversion of 10,000 c.f.s.	Assumed Diversion of 14,000 c.f.s.
	Inches	Inches	Inches
Michigan-Huron	3.07	7.4	10.3
Erie	2.6	6.1	8.6
Ontario	1.9	4.5	6.3
Rapide Plat	2.8	6.8	9.6
Cornwall Canal	2.1	5.0	6.9
Coteau	2.2	5.4	7.6
Montreal	4.3	10.25	14.4
Lanoraie	2.2	5.4	7.6
Sorel	2.5	6.0	8.4

It is represented in the pleadings of the applicants that the fluctuations of the lake levels, some of which are undulations of surface recurring every few minutes, some of which are larger fluctuations occasioned by storms and barometric changes, others of which are semi-annual, the level being highest in summer and lowest in winter, and, still others extending over long periods or cycles of say seven to ten years, are so great and so irregular that a lowering of the lake levels of even six or eight inches cannot be distinguished and is not, therefore, detrimental in practice to navigation interests, because vessels must always load so as to be prepared for the lowest levels of water which are likely to occur during the time of any trip. This is denied on behalf of Canada because whatever might be the natural level of the lakes, at any particular season or moment, that level would always be reduced by artificial lowering. If, for example, it would at a high water season or high water movement, under natural conditions, be 24 inches above the average level it would, by the artificial lowering of 7 inches, be reduced to only 17 inches above the average; and, if at a time of low water when under natural conditions the level would have been 24 inches below average, it would, by the artificial lowering, be reduced to 31 inches below the average; and, as the practice of the larger vessels is to load to the greatest safe draft in time of high water as well as in time of low, the reduction of level would be detrimental in time of high water as well as in time of low, and the detrimental effect of artificial lowering of the water would therefore be felt at all times and under all conditions.

For example since 1900 there have been only 17 months in which the level of the lake has been as high as the average of 52 years (viz. 581.35). In every case had this diversion been in existence the level would have been below. In addition to this in five months in that time the lake would have been lower than the lowest mean 579.0.

As the water at the foot of the Sault Ste. Marie canal is

only from a foot to a foot and a quarter above that of Lake Huron it follows that any fall of lake level will cause a similar drop at the canal, the lower sill of which is a barrier that all vessels trading to Lake Superior must pass. When Lake Huron is at its extreme low level of 579.0 the Poe lock sill will have over it only 17.43 feet, and the Canadian 17.76 feet. Reduce this by 7.4 inches when each inch in draft means 25 to 110 tons of freight according to size of vessel, and it will be seen what a heavy toll will be exacted from the lake carriers.

In the St. Lawrence river any interference with the depth is very serious. All freight vessels passing east, take advantage of the smaller rapids, such as those opposite Cardinal, Rapide Plat, and Farrans Point, to shorten the passage by escaping the tedious process of locking down. In Rapide Plat these vessels experience no difficulty at mean water, but, when a less depth rules, they either take the canal or lighten their cargoes. Take six inches off the depth, the rapids must be avoided during all low water seasons.

When the dredging operations were undertaken a few years ago certain depths were decided upon and the vessels trading to the various ports always load to the last inch allowed. A reduction of this depth makes it impossible to load so deeply and the harbous and channels must be dredged to allow trading under the old favourable circumstances.

An approximate estimate, by officers of the Canadian Department of Public Works, of the amount that will be required to place the harbours in Lake Huron, Lake St. Clair, Lake Erie, Lake Ontario, Detroit river, St. Lawrence river, not including entrances to canals near Montreal harbour, in the same condition as without diversion places the cost at not less than $11,367,000.

All canals have been designed for a certain draft at low water, Sault Ste. Marie 18 feet and the others 14 feet. If this diversion be permitted five to eight inches will be taken from these depths and much of their usefulness will be gone.

At Sault Ste. Marie, to repair the damage done by this diversion will mean the reconstruction of nearly the whole lock, because the lower sill and bottom must be lowered over seven inches. In addition the lower approach for a long distance must be deepened the same amount.

The same remarks apply to the upper and lower locks, the guard locks, the upper and lower approaches and the upper reaches of the Welland, Galops, Morrisburg, Farrans Point, Cornwall, Soulanges, and Lachine canals, the lower lock and

entrance to the Trent and Rideau canals, and the deepening of the Murray canal and approaches in which there is no lock. The engineers of these canals estimate the cost of this work at not less than $6,640,000.

Montreal, Canada's national harbour, with its 160 miles of improved channel and approaches, will suffer from this loss of water. The river will be affected from Montreal to tide water. Many millions of dollars have been spent in deepening and improving the channel. As autumn approaches the minimum depth of thirty feet is only available and vessels are compelled to observe great care in loading. Any reduction in this is serious to the vessel owner, the shipper and consumer. The lakes, to a large extent, feed the river and any diversion causing a diminution of supply from them must be opposed.

To restore depths in Montreal harbour and the ship channel it is estimated will cost not less than $930,000.

From these figures from Canadian harbours, Canadian canals, Montreal harbour and the ship channel, it will be seen that $18,937,000 at least will be required to restore conditions, as regards depths upset by this proposed diversion through the Chicago Drainage canal. This amount would be really a contribution from Canada to that work and should be considered in striking estimates for comparing that project with other means of sewage disposal.

From this it will be seen what an effect this diversion will have upon the most important inland waterway in the world. The damage is not only to the lakes, but to the immense works that have been constructed that we may derive the very fullest advantage from them, viz. the connecting rivers, canals, and harbours. Whilst the United States Government is interested in expenditures necessary to restore depths in its Soo canals, improved rivers, St. Clair Flats canals, and numerous harbours, Canada is vitally concerned in the same way in her harbours, her unequalled canal system and her national port of Montreal.

To allow anything to impair such vast improvements would be a retrograde movement in two ways, namely, sacrificing work already completed and allowing a loss of valuable water for dilution of sewage that might, and should have been, attended to by other more modern and sanitary methods. Other cities less wealthy and less important are compelled to look after their sewage without injuring neighbouring communities and why not Chicago? Had the divide not been there

they would have ere this completed the sewage disposal plant that must be undertaken very soon.

This loss in carrying capacity will be felt not only in nearly all the autumn months when we experience the annual low water, but also in all except the very high water years, it will mean earlier, longer and more frequent periods of low water, such as pertain now, as well as a lower low water than nature intended. In the autumn, grain from the western provinces is rushed to the head of Lake Superior and it takes the whole fleet all its time to prevent the elevators being filled before the close of navigation. If the carrying capacity of every boat is reduced from 150 to 100 tons each trip, congestion is sure to come and this is a condition the Canadian Government is trying to prevent.

That these seemingly small changes are important and divert traffic may be seen from the fact that in 1905, when the water in Lake Huron reached a minimum of 580.66 during the season of navigation and had a mean level for the year of 580.95, there passed east through the American canals at the Soo 32,632,268 net tons and through the Canadian canal only 4,146,740 net tons. Practically all the large carriers with grain, iron ore, flour and wheat passed through the United States canals.

In 1910 when the water in Lake Huron reached a minimum of 579.51 during the season of navigation and had a mean level of only 580.15 the Canadian canal with its three inches more water carried the bulk of the heavy freight east and passed nearly all the large carriers, the figures being Canadian canal 31,531,036 tons, and United States canals 15,602,673 tons.

That is to say, that, with plenty water, (19.89 feet to 20.78 feet in the Poe lock), the Canadian lock passed only 11.3 per cent of the freight, but, with low water (18.08 to 18.73 feet in the same lock) the extra three inches in the Canadian lock increased these figures to 67 per cent.

Under the present rapid development of our country, the question of improving our waterways and harbours and providing adequate transportation facilities, is a most vital one. Our main transportation problems are along an east-and-west line, with the distances very great. Cheap rates of transportation are a necessity for interchange of products at fair prices between the East and the West, and nothing helps more to provide this result than the improvement of our natural water transportation routes and supplying adequate depths in our channels and harbours.

Acting upon the assumption that all channels connecting the lakes were to have a depth of 20 feet at extreme low water and that our canals were to have 14 feet over their sills the vessel owners and the naval architects on both sides of the line set themselves to the problem of evolving the most economical freight carrier under these conditions, and they can, with truth, say they have given us the cheapest transportation system in the world. This was all done on the assurance of the governments that such would be the case, provided only that nature did not upset calculations by allowing the water to recede beyond anything ever observed.

If now the Government allows this Sanitary District to step in and take six to seven inches off the depth intended, these vessels are no longer what they were designed for, that is to say they carry a far less load than is economical and at the same expense, because each inch in draft means from 25 to 110 tons freight. If this new condition is to remain constant a new style of vessel must be designed and the old relegated to the scrap heap, as virtually happened the carrier of five years ago. Or if the depths are to be restored they will labour under a disadvantage for many years probably the balance of their lifetime. Knowing the extent of the lake commerce one can easily see the huge loss to the vessel owner and eventually to the consumer of the freight.

In the grain carrying trade of Canada there are 70 vessels, 61 of which are what is called Welland Canal size, and 9 larger.

Every inch of draft means a difference of 22 tons in carrying capacity in the canal sized vessel and the others average 53 tons, so that every trip means a loss of 1,342 tons per inch for the Canal fleet and 477 tons for the larger vessels.

During the season the Canal vessels will make twelve trips or total loss per inch draft of 16,104 tons, or for 7½ inches less water 120,780 tons at $2 per ton, $241,560. During the season the other nine vessels trading to Georgian bay and Lake Erie will make 28 trips, or a total loss of 13,356 tons per inch, or 100,170 tons for 7½ inches at 40 cents per ton, this represents a loss of $40,068, or a total loss per annum of $281,628 to the lake freighters in freight charges alone.

This loss will not be borne by the vessel owners so that freight rates will be raised and the consumer be compelled to pay. In addition to these losses, much Canadian freight, coal and grain is hauled in United States vessels and of this we have no record, but the quantity is not small.

The Canadian grain carrying fleet can in one trip transport 8,000,000 bushels of wheat.

Every inch means 60,000 bushels, 7½ inches, 450,000 per trip. For 23 trips to Georgian bay or Lake Erie 10,350,000 bushels or more than the capacity of the full fleet for one trip.

This is a matter which concerns not only the shipping interests, but, in deed, the welfare of the whole Dominion. Our trade is developing so rapidly that we cannot cope with the demands for necessary and immediate improvements in our rivers and harbours. At the present moment, when this country is compelled to make enormous expenditures to meet the exigencies of increasing trade by giving transportation facilities, why should existing conditions be rendered more difficult for the Dominion, to benefit a city that could have solved its problems of water supply and sewage disposal by some other methods, than by diverting a large volume of water, which is bound to affect detrimentally the most important internal system of navigation in the world.

To grant the requested diversion is a retrograde step in the development of our transportation system on the Great Lakes, when it is necessary that all energies should be directed towards the advancement and furtherance of the movement for improvement in transportation facilities.

The damage accomplished by the lowering of the lakes all St. Lawrence levels cannot be computed and shown simply by the loss of carrying capacity in tonnage for vessels. There is more to consider; the loss to the public at large in delaying cheaper rates; the loss to the country in rendering all harbour and channel improvements more costly and retarding their completion.

Mr. Hering in his report dated 15th October, 1907, page 35, to the President of the Sanitary District says that if the lowering of the lakes amounts to 6 to 8½ inches on a diversion of 14,000 c.f.s. the prohibition of that amount would certainly be in the interest of Chicago no less than of the entire lake region. We have shown that near the low water stages the lowering is from 4¼ to 7½ inches for a 10,000 c.f.s. diversion, and surely if such a strong advocate of the Drainage canal would stop diversion for a lowering of 6 to 8½ inches, less enthusiastic persons are justified in asking for that treatment when the lowering is 4¼ to 7½ inches.

Mr. Hering in the same report, same page, suggests a remedy in the shape of converting Lake Superior into a storage reservoir. The question of Lake Superior storage was taken

up by the International Waterways Commission in connection with its report on the Regulation of Lake Erie (see pp. 76-81) and the conclusion reached was that "the use of Lake Superior as a storage reservoir cannot be successful if navigation is to be maintained unimpaired on Lake Superior and the St. Mary river."

A dam and controlling works at the outlet of Lake Erie have been suggested to regulate the level of Lake Erie and incidentally raise the low-water level. A careful study of this proposal by the International Waterways Commission has shown that it is not feasible.

All compensation schemes are fraught with great difficulties both physical and international. No dams or weirs can be constructed in the boundary waters without the sanction of both countries.

Many shoals and reefs that are just dangerous will become very much so by having less water upon them and extending further into navigable channels. As it is not usual to remove these, extra buoys must be placed.

As government harbours, wharves and piers are affected injuriously, so private parties, not very well able to afford dredging will be compelled to shoulder their losses. True they can by treaty enter action in the United States courts and claim damages, but no private citizen can or will ever avail himself of this right unless his loss be very great.

With the fall of the water to a new datum mark below that on which all harbour works have been constructed, many crib foundations that carry concrete superstructures will have their upper timber exposed for long periods and rot will set in to the injury of the concrete. This is a damage that cannot be easily estimated and none has been allowed.

The diversion of 10,000 c.f.s. is used to create 56,000 horse power at Lockport and Joliet, but the same quantity of water used for power by the St. Lawrence route would give nearly 300,000 h. p.

As the final diversion for the dilution method of sewage disposal rested upon the question of comparison of cost to the people of Chicago of it and other feasible methods, it would appear that outside communities and interests were neglected. Had the citizens of Chicago been told that they must restore conditions in Canada at a cost of $18,937,000, and in other lake harbours at fully the same cost, they would have learned that the dilution method would prove by long odds the most expensive.

This diversion is a matter of great importance to Canada on account of her peculiar make up. A vast area of wheat producing territory separated from the manufacturing section by a long extent of non-productive wilderness. West of the Great Lakes district is her vast undeveloped grain producing area, only a small fraction of which has yet been touched. For many years the bulk of its produce must be exported and for such freight the bulk freighter is at once the cheapest, most convenient and best. Canada is now completing her third transcontinental railway but all the world knows land transport cannot cope with such a system as nature has offered in the Great Lakes and the St. Lawrence. Canada contemplates vast expenditures in the near future in her Welland, St. Lawrence and Ottawa river canals to enable her to take better advantage of her great inheritance and it would be both criminal and suicidal to throw away what nature has thus provided.

This question of diversion is a dangerous one to play with; it will not down with this application. Chicago will not be satisfied now and there is little reason why the next request for diversion should not come from some community to divert directly from Boundary waters with as great injury to navigation as this will be. If one community be granted such great privileges, it will be most difficult to refuse others.

Whereas the application of the Sanitary District state "that it has for some time been engaged in investigating methods and devising plans for the treatment of the sewage with a view to requiring less water for its safe dilution in the future. The methods of other states and countries for such treatment of sewage are not as yet entirely satisfactory to all concerned and any changes of methods for large cities must necessarily require several years." And Mr. Williams, counsel for the Sanitary District, in his argument at the hearing on the 25th of February last, discussed the case from this standpoint.

In answer to this branch of the case the following statement is prepared by Mr. John Kennedy, Montreal, assisted by Mr. R. S. Lea, and Prof T. A. Starkey, M. D., and submitted:

In the present application what is asked is "Permission for the Sanitary District of Chicago to withdraw from Lake Michigan through the Chicago river and Calumet river—not to exceed 10,000 cu. ft. of water per second." It would be physically impossible to withdraw the desired water from Lake Michigan without first stopping and otherwise disposing

of the natural flow of these rivers and reversing their flow to such extent as to draw inward from Lake Michigan the 10,000 cu. ft. per second asked for, and the effect of so doing would therefore be the abstraction from the water supply of Lake Michigan all the natural flow of the rivers in addition to the 10,000 cu. ft. of lake water which it is desired to draw inland. The estimated average natural flow of the Calumet river into the lake is about 800 ft. per second, and that of the Chicago river is about 300 cu. ft. per second, which, added to the 10,000 ft. of fresh water it is desired to withdraw from the lake, makes a quantity of 11,000 cu. ft. per second of the water supply of Lake Michigan, which would be directly and indirectly abstracted from it, and turned into the Chicago Drainage canal and thence into the Mississippi. The effect of the abstraction of this quantity upon the level of Lake Michigan, of Lake Huron and of Georgian bay to which it is joined would be to permanently lower their surface about seven inches.

It is, therefore, to be clearly understood that the granting of the request of the applicants as it stands would allow both the drawing of 10,000 second feet of water directly from the lake and diverting from its ordinary supply the flow from the Calumet and Chicago rivers making in all about 11,000 ft. per second, will most seriously damage navigation.

The application states that the flow from Lake Michigan as permitted by the Secretary of War is limited to 4,167 cu. ft. per second. In the report on the Sewage Disposal of the Sanitary District by Mr. George M. Wisner, October 12th, 1911, it is stated that the average flow during June, July and August, 1911, was 7,065 cu. ft. per second. The application further states that the present population whose sewage is to be disposed of exceeds 2,500,000 persons and is rapidly increasing and that the only method at present available for disposing of the sewage of this population is by diluting the same with water withdrawn from Lake Michigan and flowing through the Chicago Drainage canal. It is further added that at least 1,000 cu. ft. per second is required to dilute the sewage of 300,000 people in this way and hence it is alleged that the quantity at present permitted to be withdrawn is insufficient.

The statement that dilution is the only method at present available must be understood to mean that Chicago has not so far adopted any other method, and not that no other method could have been adopted or has been made available. The

fact is that Chicago has taken no measures whatever so far to purify its sewage, although methods of sewage purification have been studied and brought into successful use in a great many cities in Europe and also in America during the last thirty or forty years.

For example, the city of London (dealing with sewage of 6,000,000 people) before discharging its sewage into the river Thames, removes the sludge or suspended matter by chemical precipitation, the sludge being then carried to sea in tank steamers.

In Manchester, England, the sewage of a population of about 600,000 people is first treated and then turned into the Manchester Ship canal, not only without causing any nuisance, but actually improving the canal water as supplied by its feeder, the Irwell river. These works have been in operation since the year 1900, or about the time of the opening of the Chicago Drainage canal. The method of purification employed there is by septic tanks and contact beds and is referred to in the report of Mr. Wisner (p. 26) as one of the methods considered for the purification of certain portions of some of the outlying districts of Chicago.

In Birmingham, England, the sewage of a population of practically 1,000,000 people is purified by tank treatment and sprinkling filters and is then discharged into a stream whose ordinary flow is only about 45 cu. ft. per second, or considerably less than the volume of the purified sewage. Dozens of other cities in England similarly discharge their treated sewage into comparatively small streams.

In the Emscher district, in Germany, with a population of about 2,000,000, the sewage is being purified and turned into a stream whose natural flow is from 200 to 300 cu. ft. per second.

In America, the city of Columbus, Ohio, with a population of about 175,000 people, purifies its sewage by tank treatment and sprinkling filters. The effluent is then discharged into the Scioto river, whose average flow varies from 30 to 50 cu. ft. per second. This dilution for the present population is much greater than that at Birmingham, but still amounts to less than ½ cu. ft. per second per thousand of population.

The city of Baltimore, Maryland, with a population of over 700,000, has installed a plant consisting of tanks and sprinkling filters for the purification of its sewage. It is proposed to further treat the effluent from this plant, already inoffensive and nonputrescent, by filtration through sand or

by chloride of lime, for the purpose of removing or destroying the germs, so as to protect the oyster beds down the river.

Toronto, with a population of 450,000, not only purifies its sewage by sedimentation, but, in addition, filters its whole water supply.

It is to be noted that in all these cases of proper sewage purification the quantity of water for diluting the final effluents is quite insignificant.

Elaborate series of experiments and investigations have been made during the last twenty or thirty years or longer. Notable among these are the experiments of the Massachusetts State Board of Health, which have been carried on continuously at the Experimental Station at Lawrence since 1887; the Manchester experiments (1896 to 1899), experiments at London, Birmingham, Leeds, and several other places in England; experiments carried out by Dr. Calmette at Lille, France, and by Dr. Dunbar, in Germany, and upon the results of these experiments a great many plants have been built and are successfully operating in practice, so that the subject of purification of sewage is far beyond the experimental stage.

These references prove that methods for dealing with sewage are available, and have been available for the last fifteen or twenty years, which are not only superior in every way to the dilution method, but are undoubtedly better for the preservation of health, which is the point urged in the application.

Mr. Hering in his report to the International Waterways Commission (December 15, 1905, p. 228) comes to the following conclusions as regards the comparison between purification and dilution methods:

"3. The extension of the dilution method to the outlying territory is not the only way of preserving the lives and health of the people of Chicago.

"4. For the Calumet area, as well as other districts, there are several methods for the disposal of sewage as effective as the present method of dilution in preventing the pollution of the lake waters."

Mr. Hering, in a subsequent report on the Sewerage of the Calumet District, addressed to the President of the Sanitary District (October 15, 1907, pp. 32-3), in discussing the question of choice as between the purification and dilution methods, expresses an opinion that the choice is largely governed by the question of the annual cost as represented by a balance between expenses and receipts, and that the dilution method for a population up to about 1,000,000 is the cheapest

only because it admits of disposing of water-powers created by the water used for dilution (4,000 cu. ft. per second) which he estimates at 22,500 horse-power.

It should be here noted that the basing of choice of methods as between dilution and purification on the returns yielded by the development of water-power, is wholly unjustifiable; because it is based on the taking of water from Lake Michigan to the damage of fast navigation and other interests throughout the whole extent of the Great Lakes, their connecting rivers, and the St. Lawrence, and a great lessening of the power which may be developed on the Niagara and on the St. Lawrence rivers.

Mr. Wisner, Chief Engineer of the Sanitary District, in his report of October 12, 1911, which report is indorsed by Mr. Elicott, Electrical Engineer, and by Messrs. C. D. Hill, W. A. Evans and Martin C. Schwab, members of a commission appointed by the Trustees of the Sanitary District, has arrived at practically the same conclusion as to the efficiency of the purification by tanks and sprinkling filters. He says in substance, as regards the Calumet District that even for the dilution method, tank treatment for the elimination of solid matter will be necessary and that at a later date it will be necessary to instal sprinkling filters or other treatment in connection with the settling tanks, and goes on to indicate sites suitable for the installation of the purification plants.

A similar method of treatment is recommended for the 39th street pumping station, the North branch and other districts, that is, the installation of sedimentation tanks followed later by sprinkling filters.

All the cases cited, many more which could be cited, and the above quoted opinions of the engineers of the Sanitary District go to prove that it is not necessary to withdraw water from Lake Michigan and to dispose of the sewage of either the City of Chicago or the outlying districts by the dilution method, but that methods of purification of sewage are not only feasible but are adopted with satisfactory results to the lives and health of other communities and can also be adopted with the same results for Chicago and its outlying districts; and that not only would this have the effect of ridding Lake Michigan of much pollution but it would rid the Illinois and Mississippi rivers of the large quantities of sewage, diluted though it be, which the present method of dilution pours into them. It is to be noted also that the experience of other cities, notably the experience of Manchester with the Man-

chester Ship canal, shows conclusively that the natural discharge of the Chicago river plus say 1,000 second feet drawn from Lake Michigan for navigation purposes, would be amply sufficient to carry away through the Drainage canal the purified effluents of Chicago and the whole Sanitary District.

Although not stated in the application, it is obvious that the desired 10,000 second feet of water is intended to be used to assist in conserving life and health by making it possible to discharge the untreated sewage of two and a half millions of the people of the Sanitary District into the Illinois river instead of into Lake Michigan and thus endeavor to prevent the lake water being made unfit for domestic use, but the fact is that the lake water in the vicinity of Chicago is tainted and unwholesome whether the sewage be kept out or not. Chicago is at the stagnant end of what is practically a stagnant lake, fed only by small streams, nearly of all of which discharge into the sewage of a large and rapidly increasing population and the drainage wastes of large and growing industrial establishments. The lake is further polluted by the sewage discharged by trading and passenger steamers which everywhere traverse its waters and throng its ports and which are especially numerous at Chicago. The effect of drawing so great a quantity of water as 10,000 second feet from the lake at Chicago is therefore to draw toward the waterworks intakes the worst water of the lake and to that extent not to conserve but to injure the health of its people.

Milwaukee, on the side of the lake and, therefore, in a better situation than Chicago for obtaining wholesome water from it, has found it necessary to adopt measures both for treating its sewage and filtering its water supply.

Lake Ontario is not a stagnant lake but has the Niagara flowing through it and a less dense surrounding population than has Lake Michigan, yet is so impure that the city of Toronto has deemed it wise for the preservation of health to instal a large and modern filtration plant for its water supply and a sewage purification plant in addition.

Montreal, which takes its water supply from the river St. Lawrence—the outlet of Lake Ontario—and is situated at the foot of a series of great rapids which tend to purify the water, is also installing a great filtration plant to purify its supply. A neighboring waterworks system which serves nearly all the suburban towns, is doing the same.

Cleveland, on Lake Erie which has the Detroit river flow-

ing through it, is understood to have also determined upon the installation of a waterworks filtration plant.

Chicago, because of its peculiar position and its vastly greater land and floating population is in far greater need of a waterworks filtration plant in order to obtain pure water and thus really conserve the life and health of its people. With such plant installed and any modern system of sewage purification adopted, there would be no need for drawing such large quantities from the lake as to be detrimental to the navigation interests and to the whole chain of the Great Lakes and their outlet rivers.

The application states that the Sanitary District has been engaged for some time in investigating methods and devising plans for the treatment of the sewage with a view to requiring less water for its safe dilution in future, and goes on to say that, until these experiments are concluded and proper works installed, the use of additional water from Lake Michigan is essential to the health of the large population of the City of Chicago and the Sanitary District. Mr. Williams, in pleading, says, that these experiments have already been carried on for two and a half years at a cost of $100,000, which is equal to an average cost of $40,000 per annum. Mr. Hering, in his report of 1907, states that the desired 10,000 cu. ft. per second discharged through the Drainage canal will produce at Lockport, 20,000 horse-power, and at Joliet, 27,300 horse-power, which, at an estimated value of $25 per horse-power, will produce an annual revenue of $1,407,500. Obviously, it will be very profitable to continue the experimental station indefinitely, because the annual returns from the sale of power will overbalance the annual cost of continuing investigations at the experimental station by $1,367,500; and, under such conditions, it cannot be expected that Chicago will be in any great haste to cease investigations and adopt one or more of the well known methods of sewage purification and, thereby, deprive itself of the plea of necessity for drawing the water from Lake Michigan, which yields such enormous profits in the selling of power.

The effect of drawing the quantity of water already drawn from Lake Michigan, and passing it through the Chicago river and Drainage canal, was shown at the hearing of the 28th of February, 1912, before the Secretary of War, to be decidedly detrimental to the use of the Chicago river as a navigation channel and harbour basin, by reason of the strength of the current which is created, and the passing of

10,000 second feet, for which permission is now asked, would be greatly more so. The increase in the quantity of water passed through the river wil increase the velocity of the current in direct ratio, but increase of velocity increases its dynamic force, that is, its damaging power in the handling of vessels, as *the square of the velocity.* The quantity of water which may be drawn from the lake under the existing permission of the Secretary of War, is 4,167 second-feet, but the actual quantity, according to Mr. Wisner's report (diagram p. 6) is about 7,000 second-feet, the actual effect is to increase its damaging forces 2.8 times and the effect of passing 10,000 second-feet would increase its force 5.75 times. Similar effects are, and would be, produced in the Drainage canal. The 4,167 second-feet which may be drawn from the lake under the existing permission, plus 300 second-feet the intercepted average natural discharge of the Chicago river, and, say, 1,100 second-feet pumped by the Chicago waterworks for city use makes a total discharge through the Drainage canal of 5,567 second-feet. This, in the rock section of the canal having a cross section of waterway of 161′ x 22′ makes a current of about a mile an hour which is quite safe for navigation but, if the draft through the Chicago river be increased to 10,000 second-feet plus the 300 second-feet from the Chicago river and 1,100 second-feet of waterworks pumpage the current would be raised to about 2.15 miles an hour and its strength increased over 4½ times, which would be dangerous.

It is urged, therefore, in view of the foregoing facts and considerations, that the application for permission for the Sanitary District of Chicago to withdraw from Lake Michigan through the Chicago and Calumet rivers—not to exceed 10,000 cubic feet of water per second—be not granted.

Respectfully submitted,

Daniel Mullin, K. C., Counsel.
John Kennedy, Consulting Engineer.
A. St. Laurent, Assistant Deputy Minister Public Works of Canada.
Wm. J. Stewart, Chief Hydrographer.
V. W. Forneret, Superintending Engineer, St. Lawrence Ship Channel.

Representing the Government of Canada.

Mr. James White, Secretary, Commission of Conservation, Canada, read the following memorial:

Sir,—I have the honour to present herewith the views of the Executive Committee of the Commission of Conservation,

Canada, in regard to the application of the Board of Trustees of the Sanitary District of Chicago now before you.

The subject has been considered by the following members of the Executive Committee:

Hon. W. C. Edwards.
Sir Edmund B. Osler.
Hon. H. S. Béland.
Dr. J. W. Robertson.
Dr. C. C. Jones.
Mr. J. F. Mackay.

The views therein expressed are the unanimous opinions of the Committee.

The proceeding is understood to relate to the application of the Board of Trustees of the Sanitary District of Chicago, for a permit to increase the diversion of water through the Chicago Sanitary canal from 4,167 cubic feet per second to 10,000 cubic feet per second.

(1) In support of the application it is urged that the increased quantity of water is necessary to prevent the sewage of the Chicago Sanitary District affecting the water of the Desplaines and Illinois rivers to such an extent as to be a menace to the health of the inhabitants of the territory traversed by these streams. The charter of the Sanitary District provides that a dilution of 333⅓ cubic feet per second shall be provided for every 100,000 inhabitants of the District, which is double the dilution that the British Rivers Pollution Commission consider necessary.

During the trial of the suit of the State of Missouri against the State of Illinois and the Sanitary District of Chicago much expert evidence was adduced to cast doubt upon the efficiency of dilution by running streams. Be this as it may, it is unquestionable that the City of Chicago cannot reasonably expect that, with the wonderful growth of her population, she shall be allowed to make additional diversions to conform to the requirements of the Drainage Act, regardless of all the important interests affected thereby.

It is urged, therefore, that no additional diversion be permitted, but that the City of Chicago be compelled to purify its sewage to such an extent that, with the increase of population, the effluent will still comply with the best standards of sewage dilution. If based on the standard established by the charter of the Sanitary District, the present permitted flow of 4,167 cubic feet per second would meet the requirements of the law for a population of 1,389,000. It is obvious that,

with a bacterial reduction of one-half, this flow would suffice for a population of 2,778,000 or about 600,000 more than the present population (2,185,283) and would, therefore, suffice till about 1918. A bacterial reduction of two-thirds would suffice for 4,157,000 people—the estimated population in 1941.

(2) To proposals that Chicago treat her sewage, it has been objected that there "is no system of sewage purification now in practical use which can be relied upon to turn sewage into drinking water." To this, it is a sufficient reply to say that, it is not proposed "to turn sewage into drinking water." All that is urged is that the effluent be partially treated and sterilized sufficiently to prevent the bacterial content of the Illinois and Desplaines rivers rising above the best sanitary standards. To the objection that this does not comply with the strict wording of the Sanitary District charter, it is a sufficient answer that it complies with the spirit of it; that, lacking a permit from the Secretary of War, it would not be possible to secure the increased flow proportional to the increase of population; that the result aimed at in inserting this clause in the charter had been attained and that the clause must be interpreted in the light of reason.

(3) Respecting manufacturing wastes, the Committee on Engineering, on May 11, 1910, reported that manufacturers in the southern portion of the city and adjacent territory are allowed, unchecked, to discharge through the Calumet river into Lake Michigan, industrial wastes that endanger the water supply of Chicago. Nowhere, however, is there any intimation that Chicago has taken, or intends to take, any legal action to prevent the discharge of these wastes, some of which are stated by the Committee to be "*highly favorable to the growth of bacteria.*"

(4) Up to December 31, 1908, the Trustees of the Sanitary District had expended $60,147,883 and, to date, have expended 62 million dollars. Had they adopted a channel of a more moderate size, they would have effected a very considerable economy, and, had the money thus saved, been expended on sewage sterilization works, the City of Chicago would not now be applying for a permit for the diversion of an additional amount of water.

(5) It has been urged that the question at issue is: which has the more just claim upon the waters of the Great Lakes, the Sanitary District of Chicago or the other users of the waters? So far as Chicago's water-supply is concerned, if contaminated, it is polluted by the residents of the city and

vicinity, and it is incumbent upon these residents to prevent this contamination and to purify their water-supply by some system of filtration.

The great city of London, with a population of seven and one-third millions, filters its water-supply and treats its sewage, but Chicago urges that it is impossible for her to do either. Her extravagance is put forward as an excuse for a diversion that injuriously affects the water-line on four thousand miles of shore—an action that injuriously affects a multitude of interests in two nations, and that injuriously affects the riparian rights in a vast territory.

(6) If imposing upon Chicago filtration of her water-supply and sterilization of her sewage results in checking or reducing the present extravagant use of water and, if it results in preventing the present unchecked discharge of wastes from stock yards, glucose factories, etc., refusing her application for an increased diversion of water will prove a blessing in disguise.

(7) Though a permit has only been granted for a diversion of 4,167 cubic feet per second, the Special Board of U. S. Engineers, of which Gen. W. H. Bixby was Chairman, in its report to Congress on January 23, 1911, stated that:

"The War Department, while awaiting the definite action of Congress, has, so far, permitted the diversion of 4,167 second-feet and the Sanitary District is understood to be using 7,000 second-feet."

Evidently therefore, the Sanitary District is, without any permit or authority whatsoever, diverting 3,000 second-feet in excess of the authorized amount.

(8) In terms of comparison, the Sanitary District is, at present, diverting from the St. Lawrence system an amount equal to the extreme low-water flow of the Ottawa river at the city of Ottawa, where it carries the drainage of 34,600 square miles of territory. It is proposed to divert, in a few years, one and one-half times this flow and the Sanitary Canal has been constructed to carry an amount equal to *double* the low-water flow of this, the greatest tributary of the mighty St. Lawrence.

(9) Respecting the contention that the diversion will be required for purposes of navigation, the United States Special Board of Engineers has stated that "for purposes of navigation a diversion from Lake Michigan of less than 1,000 second-feet of water is all that will be necessary"; and, again, that "the claim that more than 1,000 cubic feet per

second is required for purposes of navigation can not be maintained."

(10) Many estimates of the fall in levels of the Great Lakes caused by the diversion at Chicago, have been made. The accompanying profiles show the levels of the Great Lakes from 1860 to 1911.

The loss of level due to the abstraction of 7,000 second-feet is coloured blue and the periods during the season of navigation 1860-1911, when the water was below the mean level for the forty-year period, 1860-99, have been coloured in red. This indicates diagrammatically what is disclosed by a study of the gauge readings, viz., that since 1890, less water has been flowing down the St. Lawrence to the sea than during the thirty years preceding that date. While part of this deficiency is due to the clearing of the forests, draining of swamps and other operations incident to the development of the country, it is undeniable that a part of it is due to the Chicago Drainage canal. The net result is: that, while navigation is handicapped by the unavoidable loss of margin due to what may be called "development operations," the situation is further aggravated by the decrease due to the Chicago diversion.

The International Waterways Commission estimated that the amounts by which the *mean level* of the Great Lakes, as derived by observations from 1860-1907, would be lowered by the diversion of 10,000 cubic feet per second are as follows:

WATER LEVEL LOWERED BY DIVERSION AT CHICAGO

	7,000 cu. ft. per sec. Inches	10,000 cu. ft. per sec. Inches	14,000 cu. ft. per sec. Inches
Lake Huron-Michigan	4¼	6¼	8½
Lake Erie	3⅝	5⅓	7¾
Lake Ontario	3	4⅓	6
River St. Lawrence and Rapide Plat	3⅝	4¾	6¾

It is to be noted, however, that these reductions are calculated for *mean water* and *would be increased at low water* thus aggravating the injury to the interests of navigation. Thus, during 1911, the stage of Lakes Huron and Michigan was between 579 and 580, at which stage, the levels were lowered 5¼ inches by the diversion of 7,000 cubic feet per second at Chicago. A diversion of 10,000 second-feet would have lowered them 7¼ inches and 14,000 second-feet would have lowered them 10¼ inches. As the average annual range of these lakes is 1.21 feet, it is apparent that even the present diversion is affecting their levels to the extent of 35 per cent.

of the annual range. It is contended that such diversion is in contravention of Article III of the Boundary Waters treaty of 1909, which forbids the construction of works that "materially" affect the levels of International Boundary waters.

(11) Respecting the contention that the changes in level caused by the Drainage Canal diversion do not concern shippers, and that, at most, the effects would be trifling, the U. S. Board of Engineers in reporting on this subject said:

"If one watched carefully the course pursued by shippers one would see that, as a rule, each vessel carries all that it can take and get out of its port, or into that it intends to reach. Vessel owners and managers are very shrewd, watchful men; they know what they can safely carry, allowing for storms and short detentions arising from passing causes; they average pretty well the practical depths, and *carry all the channel will stand.* * * * Should it be certain that these average depths were reduced three inches, or six inches, they must load accordingly and, not only the large boats, but also the small ones using the small harbours that the large ones cannot go into—all must lose the three or six inches as it may be; and, not for one or more trips, but for all trips and for all time; a diminution of capacity is not a single tax but a continuous one."

The Board estimate that a loss of draught of three inches will decrease the cargo-capacity of a vessel of 20 feet draught by 3 per cent., and of a vessel of 12 feet draught by 4 per cent. With a loss of draught of six inches, the capacity would be reduced by 6 per cent. and 8 per cent. respectively.

The Government of Canada has, at enormous cost, completed a waterway for vessels of 14 feet draught, at low water, from Fort William to Montreal, and, for vessels of 30 feet draught, from Montreal to the sea. Every inch abstracted from the available depth represents a loss of cargo capacity and a loss of income which is aggravated during low-water years like 1911.

In view of the foregoing, it cannot be seriously contended that the effects of the diversion are of little importance.

(12) The engineers of the Sanitary District have never concealed their intention to develop the full amount of water-power possible and to utilize the full capacity of the Sanitary canal, viz., 14,000 second-feet. Mr. L. E. Cooley, late Chief Engineer of the Sanitary District, has declared that it was his "hope and intention" to excavate a channel with a capacity of 16,667 cubic feet per second.

Mr. Cooley has also stated that: "It is estimated that the

flow of water that will eventually come from Lake Michigan through the Chicago Drainage canal, together with the natural flow of the river, will produce 173,000 horse-power, and, with the revenue therefrom, the State of Illinois proposes, eventually, to recoup itself for its expenditures and contribution to the deep waterway."

Every cubic foot of water abstracted at Chicago reduces the water-power that could be generated at Niagara Falls and in the rapids of the St. Lawrence, thus injuring the provinces of Ontario and Quebec and the state of New York, and owners of power on these rivers. In addition, the development of power on the Desplaines and Illinois rivers represents a great economic waste. Water used at Lockport, Ill., under a 34-feet head, has only one-fifth to one-seventh the efficiency obtainable at Niagara, to say nothing of the other power sites on the St. Lawrence. The electrical art is practically in its infancy and, with its development, the value to the community of great water powers will be enormously increased. No alienation of this valuable asset should be permitted.

The use of waters belonging essentially to International Boundary waters, entirely diverted from their natural channels, for the purposes of water-power development, is a use that cannot justly be sanctioned.

(13) It has been proposed that the Chicago Sanitary District erect compensation works. While the treaty of 1909 provides for works of this character, nevertheless, it is not the intent of the treaty to permit water diversions on the plea that compensation works may, or will, be built. Such works should only be a possible remedy to be applied in extreme and absolutely unavoidable cases. Clearly, neither the United States, nor Canada, could ever conserve the integrity of the levels of the Great Lakes by allowing to be instituted, so to speak, a policy of "diversion and compensation." Finally, no compensation works could compensate Canada for the injury done to her interests in the river St. Lawrence by the abstraction of water at Chicago.

(14) It is further contended that this diversion is in contravention of international law. Thus, Oppenheim, in his "International Law," I, 175, says:

"Just like independence, territorial supremacy does not give a boundless liberty of action. Thus, by customary International law a State is, in spite of its territorial supremacy, not allowed to alter the natural conditions of its own territory to the disadvantage of the natural conditions of the ter-

ritory of a neighbouring State—for instance, to stop or to divert the flow of a river which runs from its own into neighbouring territory."

(15) The Ashburton treaty, 1842, provides that certain channels in the Detroit, St. Clair, and St. Lawrence rivers "shall be equally free and open to the ships, vessels and boats of both parties." It is contended that any action, such as the Chicago diversion, is in contravention of the treaty inasmuch as it tends to destroy the navigable capacity of these channels.

For the above reasons, the Executive of the Commission of Conservation expresses the opinion that the application is without even the semblance of necessity, and desires to place on record its unqualified opposition to the proposition which is before you.

I have the honour to be
Sir

H. S. Beland
For Chairman

MEMORANDUM OF ARGUMENT AGAINST THE APPLICATION OF THE CHICAGO SANITARY DISTRICT FOR PERMISSION TO DIVERT 10,000 CUBIC FEET OF WATER PER SECOND FROM LAKE MICHIGAN.

Submitted on behalf of the Dominion Marine Association (of Canada) representing all the vessels engaged in Canadian trade between the head of the Great Lakes and the St. Lawrence river.

(1) It is respectfully submitted that the question at issue upon the present application, namely, whether the proposed diversion will prejudice or impair navigation, can only be answered in the affirmative.

(2) The self evident fact that the diversion of water from Lake Michigan at Chicago must affect the levels of the other lakes and of the St. Lawrence river is established by ample authority already cited in evidence, and is practically conceded by the applicants. The figures submitted at the present hearing on behalf of the Canadian Government (computed with reference to periods of depression) show that, if anything, the loss has heretofore been underestimated. They indicate a lowering of the water at various points as follows:

	For a withdrawal at Chicago of 10,000 cubic feet per second
Lake Michigan	7.4 inches
Lower sill of lock at Sault Ste. Marie	7.0 "
Lake Huron	7.4 "
Lake Erie	6.1 "
Lake Ontario	4.5 "
Rapide Plat in St. Lawrence River	6.8 "
Cornwall Canal, Lock 21	5.0 "
Coteau	5.4 "
Montreal	10.2 "

(3) The applicants then resort to the suggestion that a loss of even 6 inches need not be considered seriously, inasmuch as navigators have to contend, in any event, with such a variety of heavier fluctuations in level due to conditions beyond present control. Such a suggestion might prevail if the depths of channels, canals and harbours in the waters named exceeded the load draught of the vessels passing through them by a sufficient margin; but the contrary is true, and the fact is, that, at almost innumerable points, the tonnage afloat is restricted in carrying capacity by the question of depth of water available. Vessels are built to utilize every inch of water available over the natural barriers to navigation, and, in periods of low water, as at present, the loss in carrying capacity is enormous. For each inch of this loss actually suffered by each vessel, within the limits of a correct table of losses such as the above, it is submitted that the diversion of water at Chicago must share the responsibility.

(4) The locks at Sault Ste. Marie, the natural barriers between Lake Huron and Lake Erie now artificially lowered to certain depths, the Welland and St. Lawrence canals, and the various harbours to be entered, are the principal factors in determining a vessel's load draught. In the season of 1911 the depth available in the Canadian lock at Sault Ste. Marie represented the maximum draught available in the upper waters and that was only 17 ft. and some inches for upbound boats, and 18 ft. and some inches for boats down-bound which could be flooded out of the lock. The Welland canal, ordinarily safe at something over 14 feet, was the subject of special regulations in 1911, draught being cut down materially; while down-bound vessels in the Upper St. Lawrence ordinarily drawing 14 feet in the Rapide Plat at Morrisburg, went down the river at about 12 feet 6 or 8 inches, and suffered great delays as well, if weather conditions were adverse. Navigation in harbours and bays of limited depth all along the route was cut down in the same way. At each of these points, the proper proportion of the lost depth of

water must be attributed to the withdrawal at Chicago of part of the previous water supply of the lakes.

(5) In the year 1910, 20,899 vessels, carrying a total tonnage of 62,363,218 tons, passed through the canals at Sault Ste. Marie, or nearly five times as much as though the Suez canal which is open to the commerce of the world. Of the above vessels 12,927 carrying 25,927,661 tons, passed through on the American side, and 7,972 carrying 36,435,557 tons, pass through the deeper Canadian lock. Considering that the permitted draught of water in the Canadian lock was only seventeen feet and some inches for up-bound boats and eighteen feet and some inches for down-bound boats, and that those of the larger class could not carry within two or three thousand tons of their full capacity, the enormous effect of the loss of a few inches draught upon the earning power of the vessel and upon the trade of both countries is readily seen.

(6) The locks in the Welland and St. Lawrence canals limit the draught of vessels trading to Lake Ontario and St. Lawrence river ports, even in times of high water, and a great number of vessels passing through these canals are adapted for 18 feet navigation. With reference to such cases, there can be no question of the adverse effect of the Chicago Drainage canal upon navigation.

(7) Three statements marked "A," "B" and "C" respectively, and appended hereto, indicate with some fair degree of accuracy the loss in the carrying capacity of Canadian vessels which the allowance of the present application would entail. In statement "A" the actual figures for 1911, for a representative fleet, that of the St. Lawrence & Chicago Steam Navigation Company, Ltd., of Toronto, are set out. Statement "B" extends the computation, on the same conservative basis, to the whole Canadian fleet of bulk and package freight carriers, and Statement "C" suggests results with reference to the grain trade.

(8) Owners of the vessels last described, pay an extremely heavy insurance rate of eight per cent. per annum upon the insurable value of the hulls to cover marine risks as far east as Montreal. In order to decrease the risk of disaster from overloading and other causes, they have recently formed an association known as the Canadian Lake Protective Association, which is empowered to supervise and control navigation methods and punish offences against established rules. During 1911, this Association has been in touch with officials of the Dominion canals, including the canal at Sault Ste. Marie, and has sent out by telegraph from time to time, due

notice of the varying drafts of water permitted. It was instrumental in having penalties imposed by the Canal Superintendent at Sault Ste. Marie where vessels overloaded even an inch or two beyond the permitted draft, and similar close supervision was found necessary in the Welland and St. Lawrence canals. In the face of such facts, it is impossible to give serious consideration to the suggestion made by the applicants, that the loss of a few inches depth in the channels is of no consequence.

(9) On the Upper St. Lawrence river an extremely important passenger carrying fleet—that of the Richelieu & Ontario Navigation Company— a member of the Dominion Marine Association, is very seriously handicapped. Its steamers, which run the various rapids on the St. Lawrence, are the result of an enormous expenditure of time, labour and money in experimenting and in designing and building craft best adapted for their special purposes. They draw every inch of water available and, when the water is too low, are forced out of the rapids and into the canals. Every inch of water taken from the levels and diverted at Chicago means substantial loss to the business of this Company.

(10) All the above remarks apply with proportionately greater force to the much greater tonnage of the United States afloat on the Great Lakes and apply also in proportionate degree to the ocean tonnage trading up the St. Lawrence to Montreal through channels which share the loss of water occasioned by the withdrawal from the lakes at Chicago.

(11) It is submitted that merely local requirements for purposes of sanitation at Chicago or, at any other individual port, must be subordinate to requirements of navigation of such enormous importance over such wide areas, and especially so where, as in this case, *other methods of sanitation than the dilution method are available.*

(12) If the requirements of sanitation are to become an element in the present discussion, or, if any serious consideration whatever is to be given to the suggestion made by the applicants that the damage may be cured by compensating or remedial works in the lower reaches of the lakes and in the St. Lawrence river, then, it is submitted, a reference to the present International Joint Commission or direct consultation with the Government of the Dominion of Canada will be proper before any decision affecting the rights of the citizens of both countries is arrived at. This is particularly true with respect to the proposal for remedial works, as the Gov-

ernment of Canada must necessarily be a party to any such method of solving the problem.

(13) The recommendation of the International Waterways Commission in 1907, was not final in its character and was negative in its effect. It did not advocate the allowance of 10,000 cubic feet per second but rather the absolute prohibition of any greater amount. (Par. 43 of the Report.)

(14) For the above and other reasons it is respectfully submitted that the application of the Chicago Sanitary District should be refused.

Dated at Kingston, Ontario, the 25th of March, 1912.

FRANCIS KING,
Counsel for the Dominion Marine Association.

STATEMENT "A."

Approximate Loss in Carrying Capacity of St. Lawrence & Chicago Steam Nav. Co.'s Steamers on one inch draft at Minimum Load Line.

Name of Steamship	Length of Steamship	Loss per in.
E. B. Osler	510 feet	68 tons
W. D. Mathews	376 "	40 "
G. R. Crowe	332 "	32 "
Iroquois	260 "	24 "
Algonquin	250 "	21 "
		185 tons per inch of draft

Cargoes carried in 1911—28 each.

Average freight rate per ton—40 cents.

185x28x40=$2,156 per season loss for each inch taken from present depths or, for 6 inches, the loss would be $12,936.

A. A. WRIGHT

Toronto, March 14th, 1912

STATEMENT "B."

Canadian Bulk and Package Freight Fleet on Great Lakes:

Name of Steamship	Loss per Inch	
Emperor	75 tons	
Stadacona	70 "	
Midland Prince	65 "	
Midland King	40 "	Loss in weight carrying capacity per inch of draft at ordinary load draft.
E. B. Osler	70 "	
W. D. Matthews	40 "	
Collingwood	45 "	
G. R. Crowe	35 "	
Agawa	37 "	
	477 tons	
Add 61 vessels of canal size at say 22 tons	1,342	Tons loss in weight carrying capacity per inch per trip or cargo.
Total	1,819	

The St. Lawrence and Chicago fleet lost 185 tons per inch per trip, and, at a low freight rate, $2,156 per inch per season. A total loss of ten times as many tons on the whole Canadian fleet (1819 tons) would amount, at a similar low freight rate, to $21,560 per inch per season, or to $129,360 for six inches.

If, in the next decade, the fleet increases at the same rate as in the past decade, this would be over a million dollars loss per annum.

N. B.—On the long haul to Montreal rates might run to $1.50 or $2.00 per ton instead of 40 cents taken above, but, of course, there would be fewer trips, say, 12.

STATEMENT "C."

The Canadian grain-carrying fleet can float, at one time, if fully loaded, to, say, 18 feet draft, at least 8,000,000 bushels of wheat.

1,800 tons loss per inch of draft, even at only 2,000 lbs. per ton, is equivalent to 60,000 bushels, and, at 6 inches loss, this would be 360,000 bushels, or a full cargo for the largest vessel afloat on the lakes. At only 23 trips per season to the Bay or Buffalo this would be 8,280,000, or more than the full capacity of the whole fleet.

COPY OF RESOLUTION OF THE KINGSTON BOARD OF TRADE

KINGSTON, ONTARIO, March 23, 1912

RESOLVED—That the Kingston Board of Trade vehemently protests against the diversion of the waters of Lake Michigan by the Chicago Sanitary District, and against the lowering of the levels in the Great Lakes and St. Lawrence river which admittedly results from such diversion;

That, while Kingston is a lake port occupying an important position at the foot of Lake Ontario and at the head of the St. Lawrence river, and affords trans-shipment facilities for a great part of the grain trade from the West, nevertheless, this protest is not made for entirely selfish reasons, but rather, because the diversion of water to provide this simple but wasteful method of disposing of the sewage of a single city, entails enormous loss and damage to navigation interests as far down the chain of lakes and river as tidewater, works great injury to the trade and commerce of the country, and threatens, if permitted, to form a precedent for further depletion and damage in order to satisfy the merely local and selfish demands of innumerable other municipalities;

That, for the benefit of both nations, the tremendous investments made in vessel property, and in canals, channels and harbours on the lakes and the St. Lawrence, and the invaluable trade facilities developed in this great waterway should be safeguarded and preserved, and that no local interest should be permitted in any way to prevail;

And, that the Government of the Dominion of Canada be urged to take every step possible to prevent the allowance of the present application of the Chicago Sanitary District.

Signed on behalf of the Kingston Board of Trade, at Kingston, Ontario, March 23rd, 1912.

EDW. RYAN, President
J. H. MACNEE, Secretary

STATEMENT OF F. S. SPENCE, ACTING CHAIRMAN OF THE TORONTO HARBOUR COMMISSION

MR. SPENCE: Mr. Secretary, in view of the comprehensive way in which the situation has been explained to you, I will not trespass more than two or three minutes and that, merely by offering under the circumstances, an illustration to emphasize the force of what has already been presented by these other gentlemen.

The Harbour Commissioners of Toronto, who have asked me to appear here at this time, compose a public body, having no interests to present but the public interests. Toronto has a population of something like 425,000, and is one of the largest cities of Canada, and is, with others, vitally interested in this question.

At the port of Toronto we have a landlocked harbour, of something over three square miles, being continuously increased in its area by works. Into this there have been made

two very wide channels, at an expenditure of more than $2,000,000. The construction of docks and facilities in the harbour has involved more than $4,000,000 expenditure.

The Commission I represent has property interests there, that are exercised for the public advantage, of more than $5,000,000. Into that harbour, there came last year, 3,192 vessels, with an aggregate tonnage of something over 1,600,000 and carrying approximately, one-half a million passengers, a great many of them from the United States, as was stated by the gentlemen who spoke a few moments ago.

Our situation, Mr. Secretary, is this: A part of that harbour does not provide enough water at low stages for the vessels that come in there. The vessels that come in under present conditions, generally have a draught of 14 feet, and a part of the harbour at our docks does not provide water at low stages to the depth of 14 feet, although we have dredged down to the rock. You can readily understand that, under circumstances of that kind, any lowering of the water would be a serious obstacle to the navigation at that port.

You will understand, then, how we watch with great interest the natural low-water stages which we are obliged to contend with, and how we would view with positive alarm any further permanent reduction of that level, particularly in view of our experience with the lessening of the flow in the St. Lawrence route, to any extent, which would also mean a lessening of the reservoir capacity of the Upper lakes, and, consequently, tend to further lessen what the actual flow would amount to. To cope with that, we would have to go to the enormous expense of removing the rock, or else extend our docks out into deep water; or, if neither of these things was done, it would mean a serious loss to the carrying interests in having to lighten their cargoes in order to get into the docks.

I offer this as an illustration of the situation, as presented by gentlemen who have already addressed you.

Toronto is about the only commodious harbour on the north shore. It is a harbour which vessels in stress of weather must find refuge in. That feature is one of great importance. We have come here arguing in favour of what we think our rights are. While we present the case as strongly as we can, we are not unmindful of the fact that our national interests are very vital to us, and would be considered by you, even beyond treaty terms. I think I can say that Canadians highly appreciate the attitude of the Government shown here, from

time to time, on that line, and it is a sentiment, I think, we all highly appreciate.

The other gentlemen here, I think, wish to offer some illustrations on the same line that I have followed, as to how their respective localities would be affected by this proposed diversion.

MR. DAVID SEATH, Secretary of the Montreal Harbour Commission, presented the following letter from the Harbour Commissioners of Montreal:

HARBOUR COMMISSIONERS OF MONTREAL

SECRETARY'S OFFICE

MONTREAL, 25th March, 1912

HON. HENRY L. STIMSON,
Secretary of War,
Washington, D. C.

SIR,—The Harbour Commissioners of Montreal, a body politic and corporate, constituted by Act of Parliament of the Dominion of Canada to administer the Harbour of Montreal, respectfully submit:

That the Harbour of Montreal is the point of interchange of traffic between the ocean and inland navigation, and, in the improvement of which there has been expended \$20,000,000, and a further amount of \$8,000,000 has been voted by Parliament for the carrying out of further improvements.

That, among the improvements carried out are extensive grain elevators for the transfer of water-borne grain with a storage capacity of over 4,500,000 bushels, and the largest conveyor system in the world for the delivery of grain to vessels.

The Commissioners also have a fleet of floating grain elevators of a capacity sufficient to transfer 25,000,000 bushels of grain from lake vessels to ocean vessels in the navigation season.

That the Commissioners have also provided the most modern facilities for the expeditious handling of freight of every description.

A dry-dock and ship-repairing plant to cost several millions of dollars are in course of construction.

That the withdrawal of the quantity of water from lake Michigan now taken by the Sanitary District of Chicago is lowering the level of the lakes, and the withdrawal of a larger

quantity of 10,000 cubic feet per second now applied for by the Sanitary District, will still more lower the level of all the Great Lakes and outlet rivers, as well as the level of the waters in the canals, and will seriously reduce the carrying capacity of the vessels navigating these canals and thereby be detrimental to the navigation interests of the Great Lakes and the traffic of the Harbour of Montreal.

The Harbour Commissioners of Montreal therefore respectfully urge that the application of the Sanitary District of Chicago now before you be not granted.

We have the honour to be, Sir

Your obedient servants

G. W. Stephens, President
David Seath, Secretary

Statement of Mr. R. W. Reford

President, Montreal Board of Trade

Mr. Reford: Mr. Secretary, I represent the Montreal Board of Trade, and desire to read a short memorial that we have drawn up on the subject under consideration:

To the Honourable Henry L. Stimson,
Secretary of War for the United States:

The Memorial of Council of the Montreal Board of Trade Humbly Sheweth:

That the Montreal Board of Trade objects to the application of the Chicago Sanitary District for a further diversion of water from Lake Michigan, up to 10,000 feet per second, for the following reasons:

That Montreal is the meeting place of inland and ocean navigation and that any lessening of the water supply of the navigation routes centreing in Montreal would be an interference with her rights and against her interests;

That any diversion of water out of the drainage basin of the Great Lakes and the St. Lawrence river and into any other drainage basin is contrary to the spirit of the treaties between Great Britain and the United States;

That the Canadian Government has spent large sums in deepening its inland harbours, canals and river channels and that the municipalities on the Great Lakes have expended considerable sums in the same direction, and that all such ex-

penditure will be rendered largely nugatory by any further lowering of the lake levels, and the interests of Canadians and of the said municipalities should not be ignored:

That such deepening of the harbours, canals and inland channels has, by enabling vessels of greater draught to use them, greatly lowered the inland water freight rates in which so many are interested and that any reduction of these depths will, by lessening the draught of the vessels, involve an increase in the freight rates;

That the needs of navigation demand that the levels of the Great Lakes and the St. Lawrence river be maintained at the highest possible point, all of the harbour works, channels and shipping being adapted to present conditions, and that the proposed diversion of water will alter these conditions materially to the detriment of all water transportation interests on the Great Lakes and the St. Lawrence river to below Montreal, and will occasion irreparable and permanent damage to trade;

That the demands of water transportation are increasing, and that anything which would prevent the expansion of water-carried trade should, in the interests of both Canada and the United States, be prevented;

That it has been demonstrated that the present diversion of water by the Chicago Sanitary District has lowered the levels of the Great Lakes below Lake Superior and also the levels of the St. Lawrence river, and it is certain that the diversion of more water will proportionately further lower the levels, and that such reduction of the depth of the channels means a large fixed loss in the earning power of vessels, for the decreased draught forced upon them by such reduced depths of water involves a serious lessening of their cargo carrying capacity;

That the principle upon which the application for further diversion of water is made is unsound and that, if conceded, future demands from other municipalities may be such that, to grant them, would destroy navigation in the commercial sense;

That the use of such great quantities of water by the city and district of Chicago for sanitary purposes is unnecessary owing to the advance of sanitary science, and, that the perpetuation or extension of present methods is a retrograde movement and not in the interests of public health;

That, while the Chicago Sanitary District states that its application is for a temporary use of the water for sanitary

purposes, it is known that such water is to be used also for the generation of electrical power, and that, once permanent plants are installed for such generation, the interests vested therein cannot be expected to urge any scheme which will tend to lessen their supply of water power:

That, against the benefit which Chicago will derive from the granting of this application must be set the combined losses which all the other towns and cities bordering on the shores of this waterway will suffer, and further, the power to be developed by the water proposed to be diverted will be a small fraction of the power that may be developed by the same water if allowed to remain in its own proper drainage basin;

That the flow of water through the Chicago Drainage canal should be strictly limited to the quantity of water now allowed, and that the drawing of water in excess of the present allowed quantity be prohibited by the proper authority, and measures be taken to gauge the water now diverted in order to regulate and govern the same.

The whole respectfully submitted,

R. W. Reford
President

Signed on behalf of the Council of the Montreal Board of Trade.

L. Henderson
Chairman of Harbour and Navigation Committee

Montreal, 25th March, 1912

Statement of Mr. F. E. Meredith, K. C.

Mr. Meredith: Mr. Secretary, I will be very brief in what I have to say, but will file a short brief, with your permission.

Secretary Stimson: Whom do you represent?

Mr. Meredith: I am representing the Shipping Federation of Canada and its members.

As I have not mentioned its members in the brief which I expect to file, perhaps I should do so. I represent the Allan line, the White Star—Dominion line, the Thompson line, the Cunard line, the Donaldson line, the Manchester line, the South African line, the New Zealand Shipping Company, the Head line, the Canadian line, the Hamburg-American line; and then, there are two large coasting companies, the Dominion Coal Company, and the Nova Scotia Steel Company; in addition to that, the Atlantic Steamship service of the Cana-

dian Pacific Railway, and the Atlantic Steamship Service of the Canadian Northern Railway.

All these steamship lines, I have been requested to state, are entirely opposed to the granting of this application, so far as they can oppose it.

I may state, in order to give you an idea of the tonnage, that these lines represent a tonnage of about 590,000 tons, represented by the ships, and the value, I should suppose, would be about $30,000,000.

SECRETARY STIMSON: Are these lines all interested in the navigation of the lower St. Lawrence?

MR. MEREDITH: Up to Montreal, yes; and, there, they meet the inland carriers, represented by Mr. King.

SECRETARY STIMSON: Where do they claim that the diversion of water will affect them adversely?

MR. MEREDITH: You mean the ocean carrier?

SECRETARY STIMSON: Yes.

MR. MEREDITH: In looking at the Government brief—at all events we know the calculations which the engineers of the Government of Canada have made—we find, taking the harbour of Montreal, that the depth will be lessened by 10¼ inches. That is on page 13 of the Government brief.

SECRETARY STIMSON: I wanted to get an idea of where the shoe pinched, so to speak.

MR. MEREDITH: Yes. I may say at once, that although we were satisfied, naturally, with the Government figures—we had no reason to doubt their correctness—yet they disturbed us considerably, to think that there was going to be such a change in the levels, due to the diversion of 10,000 cubic feet per second, and we employed two independent engineers, and their estimates as to the lessening of water in the Montreal Harbour are even slightly greater than is the Government estimate, mentioned on page 13 of Mr. Mullin's brief.

Further down from Montreal, at Lanoraie, which is a few miles down, the taking out of 10,000 cubic feet would mean a lessening in depth of 5.4 inches; and at Sorel, 6.0 inches.

I do not think it is necessary for me to state that the object of all Trans-Atlantic boats is to get up to top of the navigation head as far as they can get. That has been the history of navigation in the world, and the Government of Canada has expended millions of dollars to enable these Trans-Atlantic boats to get to Montreal. We have a minimum draught there, or are supposed to have, of 27½ feet at low water. We load our ships to avail ourselves of every inch in that chan-

nel, and, during the low water, we have not an inch to spare. What is going to happen will be this: that if these figures are correct—and we have every reason to believe the figures are correctly quoted by the Government, and verified by our own engineers—we will really lose at the very least, during the low-water months, which in Canada are about four months—August, September, October and November—by the abstraction of this water—this 10,000 cubic feet—10 inches of our draught. Ten inches of our draught, roughly speaking, would mean, working it out as carefully as we can on our present fleet—of course the fleet is increasing each year and the loss would be greater each year—about $332,685. That would be the actual loss; that is working it out, as I have shown, in the brief that I will file.

General Bixby: For how many inches of draught?

Mr. Meredith: Ten inches of draught; during the low-water period, that is, which we calculate will be four months. That, we say, is taking the least loss we will suffer with the present fleet. The boats, as we all know, are getting larger. We have only to look at New York harbour and the other harbours of the world to see that that is true, and the larger the boats the cheaper the freight and the cheaper the merchandise to the consumer. If these figures are correct, the remedy, even if the Government of Canada were prepared to remedy and put back this ten inches by dredging, would not meet the trouble, because, even if they were prepared to do that, according to the figures which the engineers have given, which are referred to in the brief filed this morning by the Government, it would cost over $18,000,000 to put not only the St. Lawrence, but the St. Lawrence waterways and the Canadian waters in their former condition.

And I may say this: A great many ships that are used to carry freight to Montreal across the Atlantic are especially designed for the St. Lawrence. They get from the Government the exact depth they can rely on, and they build their ships to meet these special conditions.

Now, these special conditions, if this application is granted, are going to be entirely changed after people have invested large sums of money to build ships to suit that particular channel, and these ships will be running at a loss and will practically be on the scrap-heap.

That remedy is the only remedy, as I have said, and it will cost the Government $18,000,000, and it will take years to

bring about that remedy, and it will be an expense that will have to be borne by the tax-payers.

The ship owners also feel this: that, if once an application of this kind is granted, which will allow our water being taken from this international route, there is no reason why, if it is once granted, other municipalities should not make similar applications and obtain grants.

I thank you very much: I have stated some other propositions in my brief, which I will file with you, and I will not speak further, because I know my time has elapsed.

Statement of Mr. Andrew Allan, President of the Shipping Federation of Canada

Mr. Allan: Mr. Secretary, Mr. Meredith has practically stated the case for the Ocean Steamship lines of Canada; but I might enlarge, in a few words, on the position we take.

If it proves to be a fact that, the taking away of the water from Lake Michigan for the Chicago Drainage canal has the result of lowering the water in the St. Lawrence from Montreal to the sea, then the port of Montreal and the St. Lawrence route are very gravely affected.

We have been in the ocean steamship business for a great many years, and we have tried to assist in building up the port of Montreal; but, if this is going to have the effect it is claimed it will have, then the port of Montreal is going to suffer, very, very materially, and, as stated by Mr. Meredith, the desire is to bring the large ships to the port of Montreal. In 1906 we built two turbine steamers, the *Victorian* and the *Virginian,* and I have, here, the record of six voyages they made last autumn, beginning with the 15th of September, and ending with the 23rd of November. The depth of water was very low last year; we got down as low as 28 feet. Mr. Meredith made one error, I think, when he stated 27 feet. As a matter of fact, we got down to 28 feet.

To load these ships fully—and we should be able to load them fully, from Montreal—we have to leave a margin between the actual depth and the draught of the ship. To do that we sent these ships out at draughts ranging from 25 feet 5¼ inches, to 26 feet, and they went out on the six voyages with vacant space to the extent of 8,340 tons and 25 feet 6 inches draught, the ship drawing 26 feet 6 inches. They would have carried 15,599 tons—practically, 15,600 tons—but

they short-shipped 8,340 tons, because there was not sufficient water to allow them to go to Quebec with safety.

If there is going to be further water taken away from the St. Lawrence, then I am afraid it will have the effect of putting the port of Montreal in a very bad position, and it almost looks to me as if the port of Montreal would have to be satisfied with comparatively small steamers, nothing more than 10,000 tons, perhaps.

It may not be interesting to you gentlemen, but to a certain extent I think we ought to explain ourselves. There are bigger steamers under construction at the present time, that it is hoped will be able to come to Montreal. I do not think that we could ever hope to bring them to Montreal if the result of taking of this water from lake Michigan is going to bring about the state of affairs that it is claimed will be the result.

SECRETARY STIMSON: This shortage that you speak of was on those two vessels alone?

MR. ALLAN: Yes; I have not given the figures of what was the result with the other lines, and I have not those figures, but I am sure a great many of them suffered, probably to the same extent we did last year. And, therefore, sir, if I might suggest, from a Canadian point of view, we are very desirous that nothing shall be done to take the water away from the St. Lawrence.

MR. ALLAN submitted the following communication from the Shipping Federation of Canada:

MONTREAL, March 25, 1912

To Honourable HENRY L. STIMSON

Secretary of War of the United States

Washington, D. C.

IN THE MATTER OF THE PRESENT APPLICATION OF THE BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO FOR THE ENLARGEMENT OF THE TERMS OF AN INSTRUMENT, EXECUTED BY THE SECRETARY OF WAR, MARCH 8, 1899, AS MODIFIED BY SUBSEQUENT INSTRUMENTS, DEALING WITH THE FLOW OF WATER FROM LAKE MICHIGAN

Memorandum submitted by the Shipping Federation of Canada, a body incorporated by the legislature of the Dominion of Canada, one of whose main objects is to safeguard the

interests of navigation, more especially of the St. Lawrence route, and whose President and members are the representatives of all the Atlantic, South African and Australian steamship lines trading to and from the St. Lawrence, and, also, of the coasting lines trading to and from the St. Lawrence, and, also, of the coasting lines of steamers trading between Nova Scotia and the St. Lawrence river.

The Canadian Pacific Atlantic steamship lines, trading to and from Montreal;

The Canadian Northern Atlantic steamship lines, trading to and from Montreal.

The above application having been carefully considered by the above Federation, its members and the above steamship lines, it was unanimously decided to oppose the granting of the above application, since, were it granted, navigation of the St. Lawrence route would be most seriously affected, more especially in view of the resulting lowering of the levels on the Great Lakes, the canals and the St. Lawrence river proper. The Federation and the steamship lines above mentioned, rely on what would result, if the application were granted on the levels, on the information obtained and furnished by the Government of Canada in their brief submitted to you and dated March 25, 1912, which shows that a diversion of 10,000 c. f. s. would result in a lowering of the water at Montreal by ten and a quarter inches (page 13) and they have obtained a report from two independent engineers on the result to the level of water at Montreal in the event of the present application being granted, which agrees on essential points with the conclusions arrived at by the engineers of the Government of Canada.

The number of vessels now employed in the St. Lawrence Atlantic trade to Montreal is seventy-five. These vessels make an average of five voyages per season and, for three voyages during the low-water months of August, September, October and November, the average load of these vessels would be reduced by at least 10 inches, which would work out as follows:

The average load of each vessel would be reduced at 53 tons per inch, or 530 tons on 10 inches—multiplied by three voyages per season equals 1,590 tons average loss of freightage per ship. 1,590 tons multiplied by 75 ships amounts to 119,225 tons, which, at the average freight rate of $2.29 per ton, works out at $273,093 loss of freight per season.

In addition to the trans-Atlantic lines, there are some twelve large steamers regularly trading from Montreal to

South African and Australian ports, making one trip per season. At least one-half of these vessels would be affected during the low-water months to the extent of ten inches in draught, which, on the average freight of $5 per ton, would work out as follows:

Six ships, average loss on 10 inches reduced draught at 53 tons per inch equals 530 tons per ship, or 3,180 tons loss on 6 ships, which, at $5 per ton, works out at $15,940.

In addition to the above, the carrying capacity of the deep draught colliers in the employ of the Dominion Coal Co. would be materially reduced, and, as shown in the attached letter, dated March 25th, that company, alone, estimate their loss at $43,642 per season.

Summarizing the above the result shows this:

Loss of freight charges on 75 Trans-Atlantic Liners	$ 273,093
Loss of freight charges on South African and Australian	15,940
Loss of freight charges on Coal Carriers	43,642
Total loss on season	$ 332,675

It is to be borne in mind that the loss, if the levels are decreased, will not only be suffered by the ship owners but also by the consumers. The smaller the ship the higher the freight, and it is unnecessary to refer to the fact that the universal practice at present, is to increase the size of the carrying vessel.

It is a fact that a very large number of steamers at present using the St. Lawrence route have been especially designed and built for that trade, relying on the minimum depth of the present channel which is availed of by ship owners to the last inch; that the lines of steamers furnishing this memorandum have a tonnage of 592,584 tons, and a tonnage value of about $30,000,000.

The whole most respectfully submitted

ANDREW A. ALLAN
President, Shipping Federation of Canada
THOMAS ROBB
Secretary, Shipping Federation of Canada
F. E. MEREDITH
Attorney for Canadian Pacific SS. Lines, and for Canadian Northern SS. Line

STATEMENT OF MR. GEORGE T. BLACKSTOCK, K. C.

MR. BLACKSTOCK: Mr. Secretary, just a word or two, relating to the Niagara river, and the Power companies there. The intakes of those companies were designed in reference to the levels, as they then existed, at the time of the initiation of these works, and any alterations in those levels very seriously impairs the power of the companies to get their water, and, therefore, to generate the amount of power which their concessions at Niagara entitle them to generate.

Then, there is in addition to that, a very serious difficulty by reason of the accretion of ice which collects along the margin of the river. As you are aware, sir, one of the most serious difficulties every winter at Niagara, is in respect of the collection of ice at various points along the river; and you are aware, sir, that only four years ago a veritable cataclysm took place there, by which the power companies were almost entirely suspended, one of them completly suspended, and the others very seriously interfered with in their operations.

So that any diminution in the volume of water in that river is fraught with the gravest consequences to interests in that locality.

Mr. Secretary, perhaps you would allow me to offer one general observation. This is a very momentous occasion in respect of the interests that are involved here. Around the borders of these international waters are collecting very great populations, who, as time goes on, must from time to time, have increasing temptations to interfere with those problems. Now, the common sentiment of two countries, on either side, has suggested the idea of the protection of these waters, and a great precedent, one way or the other, must, on this occasion, be established: Either it must be said that the common sentiment and interests of the two countries are to be qualified by the particular interest of some one detached community, or else, that the general sentiment is to be maintained in its integrity. Now, I venture to make this observation. The proposed interference by the application now under consideration, is, as has been very well said by Mr. Mullin, extraordinary in its character. It is unheard of. Instead of maintaining the common pool between the two countries, one particular community proposes to very seriously diminish that pool. Does it not fill any ordinary mind with consternation to hear it suggested that some one community, itself the creation of the interests that it is now menacing, itself the creature of trade and commerce, should propose to skim off Lake Erie, by this

proceeding, no less than six inches of that surface. It appals me, and I venture to suggest that the onus of showing that the rights of navigation are not seriously interfered with, rests with those who are proposing the exercise of these extraordinary powers.

It is quite true, I apprehend, that you would not give any adhesion, or pay any attention to some purely chimerical suggestion of danger; but, on the other hand, is it to be said, can it be said, that that apprehension is slight and ill-founded which brings to your bar every interest from Chicago to the sea, all claiming to be seriously menaced by reason of this undertaking?

That very fact seems to me to constitute a complete answer to the application as made, and to show the very grave consequences which would ensue if it were acceded to.

RICHELIEU & ONTARIO NAVIGATION COMPANY, OFFICE OF THE GENERAL MANAGER

MONTREAL, March 24th, 1912

Hon. H. L. STIMSON
Secretary of War
Washington, D. C.

Chicago Drainage Canal

DEAR SIR:—With reference to the proposal to withdraw an additional amount of water from Lake Michigan, we respectfully beg to submit that we have been operating steamers in the passenger and freight business on the river St. Lawrence since 1867, and anything which has a tendency to lower the natural level of the waters is a matter of the gravest concern. We give you below, a description of the business and the possible effect of lowering the water levels.

Passenger

We carry passengers from the head of Lake Ontario all the way down the St. Lawrence river, running the St. Lawrence rapids, and have several millions of dollars invested in vessel property and the business is rapidly growing. Last year we transported 60,000 passengers over the Rapids Division, where the boats have to be especially constructed of a very light draught in order to get through. In this respect we have virtually built, within the past seven years, three special boats of exceptionally light draught on account of low water,

at an approximate cost of close on $1,000,000. There is never any too much, in fact, sufficient water in this part of the river and, on several occasions, owing to low water caused by natural conditions, we have been forced to withdraw the service. Last season, which was a season of low water over the entire chain of lakes, we suffered severely and were obliged to cease running the rapids a month earlier than usual.

Inasmuch as our business is a through business, run on a close schedule, making, connections with railroads, steamer lines and steamships, anything which interferes with the continuity of the service or puts one division of the line out of commission very seriously affects the earnings, and we are unalterably opposed to granting permission to withdraw water from any of the Lakes which it is known will have the effect of lowering the water further down the chain.

We contend that the importance of this traffic down the Lakes and River cannot be overestimated and that it must be protected.

Freight

An immense amount of money has been spent by the Governments of the United States and Canada, improving channels, dredging and canalizing in order to develop waterborne traffic through the chain of Lakes and the River, and the freight vessels have had the same trouble to contend with, so far as low-water conditions are concerned, as the passenger boats. Last year, vessels carrying cargoes to and from Montreal, were only able to load a percentage of their capacity which very seriously affected their operations, besides increasing the liability to accident and the cost of insurance.

We feel that any application on behalf of a particular district or locality cannot justly be considered separately, but must be judged in its relation to the whole chain of Lakes and River and their protection and general development for the benefit of all concerned.

There is every reason to believe that, in the future, low-water conditions are more liable to occur than in the past and no permission should be granted to take any water which will have the tendency to lower the depth at any other point between that and the sea.

Yours respectfully,
C. J. Smith
General Manager

REPLY OF SANITARY DISTRICT OF CHICAGO

In the Matter of the Application of the Sanitary District of Chicago for a Permit to Divert not to exceed Ten Thousand Cubic Feet of Water per Second for Sanitary Purposes from Lake Michigan.

To the Honourable Henry L. Stimson

Secretary of War

Sir:—In presenting this statement of the reasons which prompted the Board of Trustees of The Sanitary District of Chicago to make the application which is now pending, and of the reasons why the suggestions made by those who have opposed the application should not have sufficient weight to defeat the application, it is my purpose to confine myself as closely as possible to the suggestion conveyed in the course of the hearings before you, that the sole purpose of the inquiry was to decide whether or not the interests of navigation would be substantially affected adversely by the granting of the permit. I am aware that the law which gives to the Secretary of War the right to issue the permit in question was passed solely in the interests of interstate commerce, and has its life and force only by virtue of the commerce clause of the Federal Constitution. It is assumed however, that in the protection of navigation interests it will not be necessary, in order to render more profitable the navigation of the Great Lakes, to imperil the health of a substantial part of the nation.

It has apparently been assumed in this hearing that the burden of proof is upon the Sanitary District, and that it is incumbent upon it to show that the granting of the permit in question would not substantially interfere with interstate commerce, and that the use of the water of Lake Michigan as contemplated is not inconsistent with an existing law of Congress. I respectfully submit that in the absence of a positive law of Congress prohibiting the work in question the State of Illinois, in the exercise of its police power, has a right to prescribe the use to which the waters of Lake Michigan shall be put, and that such an act is valid and effective until it affirmatively appears that it conflicts with the powers of the Federal Government with reference to the control of interstate commerce.

The Supreme Court of the United States, in the case of New Orleans Gaslight Co. *vs.* Drainage Commission, 197 U. S., 453, speaking through Mr. Justice Day, uses the following language in describing the governmental character of the exercise of the powers sought to be exercised by the Sanitary District:

"The drainage of a city in the interest of public health and welfare is one of the most important purposes for which the police power can be exercised."

The law under which the Sanitary District was organized has been declared constitutional by the Supreme Court of the State of Illinois in People *vs.* Nelson, 133 Ill. Rep., and in Trustees *vs.* Wilson, 133 Ill. Rep. It is therefore beyond the stage of discussion that the act is a valid act and a proper exercise of the power of the State, and it seems elementary that that valid law, and the valid exercise of the powers conferred by it, should not be rendered of no effect or interfered with, unless it shall affirmatively appear that it conflicts with some law of Congress enacted under the commerce clause of the Federal Constitution.

It must be borne in mind that there has been no legislation on the part of Congress directly bearing upon the Sanitary District canal. The policy of the United States Government, however, has been well established since 1822. In that year an act was passed providing for the construction of a channel connecting the southern bend of Lake Michigan with the Illinois river. Another law to the same effect was passed in 1827, and the State of Illinois, by the act of 1829, accepted the provisions of the Federal acts and by subsequent acts authorized and in fact constructed the Illinois and Michigan canal.

This canal had the effect of re-establishing a prehistoric natural waterway. Geologists are in accord in saying that at one time one of the outlets of Lakes Superior, Huron and Michigan was through the valley of the Desplaines and Illinois rivers, and the Supreme Court of the United States, in the case of Missouri *vs.* Illinois, 200 U. S., 496-526, declared the physical conditions which divided the watershed of Lake Michigan from the Mississippi river watershed "* * * are of the smallest. And if under any circumstances they could affect the case it is enough to say that Illinois brought Chicago into the Mississippi watershed in pursuance not only of its own statutes but also of the acts of Congress of March 30, 1822, and March 2, 1827, the validity of which is not disputed."

The Illinois and Michigan canal, constructed pursuant to the provisions of the acts above mentioned, had a dual function. In the first place, it was a navigable waterway of the United States and has been so declared by the Supreme Court of the United States, and incidentally to the purpose for which it was designed it disposed of a considerable portion of the sewage of the city of Chicago by a partial and, at times, complete reversal of the flow of the Chicago river.

The Illinois and Michigan canal was completed in 1848. In 1871 the policy of withdrawing water from Lake Michigan for navigation and sanitary purposes in Chicago was further recognized by an enlargement and deepening of the Illinois and Michigan canal at an expense of approximately $2,000,000. By 1887 the population of Chicago had increased to about 800,000 inhabitants. It then became a serious problem to prevent a large proportion of the sewage of the city from being emptied into the basin from which is water supply was received, and there was appointed by the mayor of the city of Chicago a Commission of Sanitary Engineers to study the best method of disposing of the sewage, and at the same time protect the water supply of the city. As a result of the investigations made by this Commission the Sanitary District act was presented to the General Assembly of the State of Illinois in 1889, and became effective on July 1 of that year.

In the determination of the question as to the proper method of disposing of the sewage of the city there were brought into consultation the most eminent engineers and experts in the disposal of sewage then available. Every then known method of sewage disposal was investigated and discussed, and the dilution method adopted and the percentage of dilution determined as stated in the Sanitary District organic act. Investigations since that time have demonstrated the wisdom of the degree of dilution provided for, namely, 20,000 cubic feet of water per minute for each 100,000 of population, and this percentage is now accepted as the standard minimum rate of dilution which it is safe to apply to domestic sewage (the statements in one of the briefs of those representing the Canadian interests to the contrary notwithstanding.)

The necessity of this degree of dilution is further demonstrated by the analysis of the waters in the Desplaines and Illinois rivers, made during the year 1911 and shown in the report of George M. Wisner, chief engineer of the Sanitary District, dated October 12, 1911, and on file in the office of the chief of engineers.

I also have the honour to submit as an appendix to this

brief marked "A" a letter from Professor Edward Bartow, Ph. D., director of the State Water Survey of the University of Illinois, a copy of which has already been filed in your office.

After the passage of the Sanitary District Act work was begun in the construction of the Sanitary District canal for a distance of 32 miles from Robey street in the city of Chicago, to Lockport, Ill., at which point the canal joins the upper basin of the Desplaines river in the city of Joliet. The canal was designed for a capacity of 10,000 cubic feet of water per second, but was actually constructed of a capacity of 14,000 cubic feet per second. The canal was substantially completed in 1898, and the Governor of the State was notified, in order that he might appoint a board of engineers, as provided for in the Sanitary District act, for the purpose of making a report as to whether or not the canal had been constructed in accordance with the authority granted by the General Assembly. Before this board reported and before any water was actually turned into the canal the act of Congress of March 3, 1899, was passed, Section 10 of which gives to the Secretary of War jurisdiction over the navigable waters of the United States. The Chicago river was and is a navigable waterway of the United States over which the Federal Government has assumed control. The question of the amount of water that might safely be taken through the Chicago river in diverting its course without injuring the interests of navigation became a matter of moment and investigation, and in view of the jurisdiction conferred upon the Secretary of War by the act of March 3, 1899, an application was made for a permit to reverse the flow of the Chicago river and flow through the same a sufficient quantity of water to dilute the sewage emptying into it.

A permit was granted on May 8, 1899, by the Hon. R. A. Alger, then Secretary of War. This permit is shown as an appendix on page 36 of the report upon the Chicago Drainage canal by the International Waterways Commission, 2nd ed., 1907.

It is pertinent to note in this connection, in view of an argument presented by one of the eminent gentlemen representing the Canadian interests, that that permit makes no mention of the withdrawal of water from Lake Michigan. The limit placed at that time was a flow of 300,000 cubic feet per minute through the Chicago river. The question of lake levels was not discussed nor mentioned, and the only reason for the limitations contained in that permit are stated to be, the pro-

tection of the Chicago river and its maintenance in such manner as to protect navigation and property interests in and along the river.

Subsequently the permit then granted has been modified, always with one purpose in view, namely, the maintenance of navigation in the Chicago river, and the prevention of a current which might be injurious to such navigation. It will at once be seen that up to the time the water was turned into the Sanitary District canal, and, in fact until plans were submitted for the reversal of the flow of the Calumet river in the year 1907 the question of the effect upon lake levels was never considered or discussed and the navigation interests have never even pretended that they had any right to interfere with the carrying out of the beneficent objects of the Sanitary canal, except to require such reasonable regulations as might be necessary to protect navigation in the Chicago river.

The present canal is a growth and development of the policy of both the State and the Nation as expressed in the acts of Congress and of the General Assembly of the State of Illinois from 1822 to the present time, and it is strange that after a policy has been declared and carried out for a period of ninety years, there should be, at this late date, so strenuous an effort to prevent the protection of the lives of the people of that large community because of some supposed and imaginary injury to navigation upon the Great Lakes.

It has always been assumed by those entrusted with the care of our waterways and the protection of our navigation that the works of the Sanitary District should be maintained and carried on. This is abundantly shown by the reports presented to you upon the oral argument. A compilation of quotations from some of these reports which are deemed pertinent, together with references to the reports themselves, will be attached hereto as appendix "B."

We therefore respectfully submit that the rights of the Sanitary District to withdraw water from Lake Michigan for sanitary and domestic purposes is not now in question, and the right is reserved at all times to maintain the supremacy of those rights.

The right to control the flow through the Chicago and Calument rivers we concede is vested in the Secretary of War. In view, however, of the frequent discussions and the insidious efforts made to continually restrict the use of the waters of Lake Michigan so that they may not be used for the highest purpose for which they are fitted, the Board of Trustees of the

Sanitary District has been prompted to apply for this permit. While we are entitled to the use of the waters of Lake Michigan as a matter of right, we also believe that we are entitled to this permit from the Secretary of War, in order that there may be evidenced that "spirit of harmony and conciliation which ought always to characterize the conduct of governments standing in the relation which that of the nation and those of the States bear to each other," as expressed by Chief Justice Marshall in the case of *Gibbons vs. Ogden*, 9 Wheaton, 1; and also to make manifest that which was referred to by Mr. Justice Johnson in the same case as that "frank and candid co-operation for the general good which should always take place where there is a seeming blending of the power of the two governments, and an apparent conflict."

II

I propose now as briefly as I may, and in view of the suggestions made by those who oppose the granting of the application, to discuss the imperative necessity existing to have a permit issued as asked for.

The amount of water asked for is necessary for the protection of the lives of the people of the Sanitary District.

In the oral statement which I had the honour to submit to you I did not think it necessary to engage in a discussion as to the requirements to properly dispose of the sewage of the population now residing in the Sanitary District. In view of the discussions that have since taken place and some of the documents submitted to you, however, it seems now, not inappropriate to very briefly set forth the basis upon which the application is made in this regard.

Experts in the disposal of sewage have been studying the question of the proper degree of dilution necessary, to render sewage innocuous for many years. In 1886 the Chicago Sewage Commission, as heretofore stated, was appointed by the mayor of the city of Chicago with this purpose in view. The most eminent engineers of the world were consulted and their advice taken, and it was then found that the degree of dilution, such as is provided for in the law creating the Sanitary District, was as small a percentage as was safe. The reports of sewage experts the world over are now unanimous in declaring that the degree of dilution provided for in the Sanitary District Act, passed by the General Assembly of the State of Illinois, was proper and necessary, namely, 20,000

cubic feet of water per minute for each 100,000 of population. With a population now exceeding two and one-half millions the Sanitary District actually needs for dilution purposes alone and for the protection of the lives of its people over 8,000 cubic feet of water per second.

The rapid increase in population renders it certain that within a very short time, and certainly by the time the Calumet-Sag channel now in course of construction is completed, the full amount now asked for, namely, 10,000 cubic feet per second, will be required to prevent the sewage of the Sanitary District becoming a nuisance and dangerous to the health and comfort of a large number of people, as well as destructive of one of the great industries of Illinois, namely, the fish industry, which is hereinafter referred to.

Only one answer has been suggested to our claim that necessity exists for the additional water. Those who have opposed the application have stated with confidence that Chicago should adopt some other method of treating its sewage and protecting the lives of its people. This is easily said, but I venture to suggest that no engineer of reputation, would be willing to jeopardize that reputation by unqualifiedly recommending any system of sewage disposal for a city like Chicago.

No one has even had the temerity to suggest that there was any known method at present available which could so efficiently and *economically* be employed in the disposal of the sewage of Chicago. The only conclusion to be drawn is that those who have opposed the application of the Sanitary District care nothing about the economies involved, if those economies are to be practised in behalf only of the public. The only money which they deem important to conserve and save, is money belonging to private interests, and they seem to assume the position that it is the duty of those intrusted with the administration of governmental functions to be heedless of the expense to the public, so long as private interests are protected.

The claim has been made that many cities abroad and at home have successfully treated their sewage by methods other than by dilution. Among those cities are the cities of London, Manchester, Birmingham in England, the Essen District in Germany, and Worcester, Mass., Columbus, Ohio, and Baltimore, Md., in the United States. None of these cities, with the possible exception of Worcester, Mass., is subject to the severe climatic conditions that confront Chicago in the win-

ter time. It has been found by experiment that the best methods of artificial sewage disposal, are much less efficient during extreme cold weather than in the summer months. It has been stated that these plants are only about 50 per cent. as efficient in the colder months as they are during the warmer ones. The dilution method as now employed works automatically, while any artificial method of disposal is dependent upon the human element.

At Worcester, Mass., some 15,000,000 gallons of sewage are treated daily. This sewage, after treatment, is discharged into the Blackstone river, a comparatively small stream—in the dry-weather months, having a drainage area of only 60 square miles. Two-thirds of this sewage is treated by removing the settling solids by chemical precipitation, and the remainder is treated by intermittent sand filters. The resulting effluent is in a highly putrescible state and could not with safety be discharged into any stream that supplied the drinking water of a community. The stream is so polluted that even fish could not exist any time during the year. To treat the sewage of Chicago by intermittent sand filters would require an area of over 7,000 acres, or 11 square miles, and the expense of obtaining the necessary land and preparing beds similar to those used at Worcester would be so enormous as to make it prohibitive.

There seems to be an impression that the city of Hamburg, Germany, with a population of nearly a million, has installed a complete sewage disposal plant. This matter has been investigated, and practically the only thing that is done toward the treatment of the sewage of this community is to catch the heavier solids and remove some of the larger floating matter by means of screens. The only purifying effect this has, is to render the river Elbe more sightly to the eye than it otherwise would be. The resulting effluent from these works is practically unimproved from a chemical or bacteriological standpoint.

The city of London, on the river Thames, where the rise and fall of the tide exceeds 20 feet twice, was compelled to remove the unsightly solids from its sewage. This is accomplished by means of chemical precipitating tanks, and the resulting effluent is allowed to discharge into the Thames some ten or twelve miles below London bridge. The solids taken from the sewage are carried to sea in tank steamers. The resulting effluent by this sewage treatment is practically improved 25 per cent. but would be absolutely unfit to be discharged into a source of water supply.

Manchester treats the sewage of about 600,000 people and the effluent is discharged into the Manchester ship canal. This water is not used for drinking purposes, and such an effluent, according to the analyses made, would be dangerous to discharge directly into Lake Michigan in the vicinity of the intakes of Chicago's supply of water.

Birmingham treats the sewage of a population of approximately a million people, and the effluent is allowed to discharge into a small stream. It is true that the effluent is less polluted than the stream itself, but in the stream exist no fish. Neither the stream nor the effluent could safely be discharged into a body of water that was to furnish a community with its water supply.

In the Essen district in Germany no attempt has been made to produce an effluent from the sewage disposal plants that would be safe for domestic use. The only result that is desired is that the river into which this sewage is discharged shall not be unsightly, which has been accomplished.

In the United States, at the city of Columbus, a purification plant was installed so as to avoid a nuisance in the Scioto river, which runs through this city. This river in the summer time is practically dry and the sewage amounts to more in volume than does the discharge of the river. This plant is actually operated only during the lower stages of the river, and during the high stages the sewage is discharged untreated into the river. It is well known that this plant when operated in the winter time is much less efficient than in the summer months. The water of this river is not used for any domestic supply.

The city of Baltimore has installed a large sewage disposal plant consisting of settling tanks and sprinkling filters for the purification of its sewage. It was installed primarily to protect the oyster beds some 18 or 20 miles below the city. The effluent will be discharged into a tidal water, which will never be used for domestic purposes. As this plant has never been operated and is just being completed, it is impossible to say whether the effluent will be inoffensive and non-purtescent, as was stated by Mr. John Kennedy, consulting engineer for the Dominion of Canada.

When the systems as installed in the principal cities in the world are studied it is found that nowhere does a situation exist similar to that of Chicago, where, if any other than the present method was employed, the sewage effluent coming from a disposal station would be discharged into the

source of its water supply. Chicago is so situated that it is possible by a combination of partial purification and dilution methods to dispose of its sewage without offence to any one and with perfect safety to its water supply. It is a comparatively simple and inexpensive matter to partially purify sewage, but to so thoroughly purify it as to render it safe to discharge it into the source of a water supply is so expensive as to make it a financial impossibility for the people of Chicago.

It is unfair to compare any American city's sewage disposal scheme with those of foreign cities. The average water supply of foreign cities is about 35 gallons per capita, whereas that of American cities runs as high as 235 gallons per capita, thus making it exceedingly burdensome to treat the sewage of the ordinary American city artificially.

The Sanitary District has expended in the last three years about $100,000 in carrying on an elaborate system of experiments on practical methods of sewage disposal for conditions such as exist in the city of Chicago. As a result of these experiments the Sanitary District has adopted plans by means of which the present dilution method can be augmented and supplemented by the use of partial purification methods, so that it will be entirely possible and practicable with some additional expense to take care of the sewage of Chicago after its population exceeds three millions of people by the installation of partial purification works, the effluent of which will be diluted with water coming from Lake Michigan, which will render it innocuous and harmless to the people residing along the Illinois river, through which the effluent flows, and to fish life. But in order to accomplish this it will take a number of years to make the installations. The Sanitary District has already by official action, instructed its chief engineer to prepare plans for the installation of settling tanks to be used in connection with all new works.

Chicago, through the Sanitary District, is taking active steps to force large manufacturing concerns, such as the slaughter-house industries, to remove their trade-wastes from their sewage before discharging it into the Chicago river or the drainage canal. This action will probably cost the industries affected in the neighborhood of a million dollars. Other industries will be affected to a lesser extent, but they are to be forced to purify their trade wastes, so that as the city grows it will require less water per capita for the proper dilution of the sewage coming from this large manufacturing centre.

Generally it is the plan of the Sanitary District to install by the year 1920, at which time it is estimated that the population of Chicago will be three million people, many partial purification works to supplement the general scheme as it now exists. It is absolutely necessary that Chicago so dilute its sewage that when it reaches the Illinois river it will have so purified itself and have an oxygen content that is sufficient to sustain fish life.

As has been stated, the Illinois river is the second largest fish-producing river in the United States, the production exceeding, at the present time, 46 million pounds of fish annually, which are shipped to the dense centres of population and afford the people a cheap food. This industry in the last few years has more than trebled. However, if Chicago is unable to properly dilute its sewage, this river will become so contaminated and polluted that this vast industry will be destroyed.

In case Chicago should be prohibited from discharging properly diluted sewage into the Illinois river it would be forced to discharge it, as before 1900, into Lake Michigan, thus creating conditions worse than those which existed prior to the building of the drainage canal, when the typhoid death rate was a disgrace to the community.

The fact that the present channel and the expenditure of 70 millions of dollars would be wasted by the installation of a new plan of sewage disposal at Chicago is not the greatest element of loss to the public. The change of the entire sewerage system in the city of Chicago, which would then be necessary, would involve an expenditure of probably 100 millions of dollars; and in addition to that, the expense of installing and maintaining such sewage disposal works as might at some future time be discovered or evolved must be taken into consideration, and that expense would probably be so enormous that it would impose a burden almost unbearable by the people of Chicago, who have already borne with patience the expense of the monumental works so successfully operated at this time. Such a change could not possibly be made within the next eight or ten years, as it would involve not only the construction of disposal works but also the reconstruction of sewerage systems, the building of large intercepting sewers, and incidental to this, the tearing up of the streets and the repavement of them.

The granting of the request which we now make does not in any wise foreclose the United States Government or the Secretary of War from any action in the future if it shall be

demonstrated that the water asked for is unnecessary in the treatment of sewage. If that time shall come it will not only be proper, but, if the interests of navigation are found to have been injured, it will be appropriate for the Secretary of War to revoke the permit and compel a change in the methods.

We deal, however, not with future conditions which are uncertain and indefinite, but with actual conditions which now exist; and so long as they do exist the necessity is imperative that Lake Michigan, the great storage basin provided by nature for the comfort and convenience of man, shall be used to promote the health and comfort of those who may avail themselves thereof.

The efficacy of the present method is amply demonstrated by the records of the health department of the city of Chicago before and after the opening of the Sanitary Canal.

The death rate from typhoid fever which, prior to 1900, ranged from 25 to 170 per hundred thousand population, decreased, in 1910, to about 12 per hundred thousand.

The enormous saving of human life effected by this means, therefore, is such that any restrictive measures which would interfere with the operations of the works of the Sanitary District should be applied most hesitatingly and for the most convincing reasons. And it is no answer to this suggestion to say that other methods may be found; for, so far as I am aware, there has been no suggestion in this hearing, or at any other time or place, of a method at present available as a substitute for the city of Chicago.

III.

Let us now consider the objections urged by those who fear the effect of a further withdrawal of water upon navigation:

The objection to the granting of the permit made by those who are interested in lake navigation is based upon fears for which there is no basis, and upon speculative theories that up to this time have not been demonstrated to be of practical force. It was suggested by one of the eminent gentlemen representing the Canadian interests that the unanimity with which the protest of the navigation interests was presented, and the cohesion of forces which feared that disastrous results might flow from the use of the lake waters for sanitary purposes should be considered by you as evidence of the substantial nature of the objections which should control in the determination of the question. It may be unfortunate, but it is

nevertheless true, that whenever any project or improvement is proposed for the public benefit a large number of persons with no knowledge as to substantial damages to accrue, and actuated only by the fear of an attack on their most vulnerable point namely, their pocketbook, become extremely active, insistent and persistent in defending themselves against even a possible invasion of their so-called vested rights. On the other hand, public interests are often neglected. The body politic is inclined to be lethargic, and only is aroused after the damage has been done and the calamity has befallen the community. The lives, health and comfort of nearly three millions of people are to a large extent dependent upon the action to be taken in this proceeding. The interests of this large population are sought to be represented by a few public servants whose duties require them to conserve the public interest. While it seems impossible to arouse the interest of all this population—who will be more seriously affected than if their source of income were to be interfered with, it seems easy to arouse every interest to a surprising activity, when only dollars are involved. In fact, however, so far as anything appearing in the hearing before you up to this time, no one has been able definitely to state in what manner or to what extent the interests of navigation would suffer or the investments of the transportation companies would be impaired.

It is true that general statements have been made showing the loss of profit to a transportation company by being deprived of sufficient water to load its vessels to their full capacity.

Natural fluctuations of the lake levels, however, are of sufficient magnitude to account for every inconvenience and every loss to which transportation companies have been and may be subjected. An attempt has been made to show that the mean level of the lakes for the past ten years has been below their mean level for the past 50 years. A comparison of the lake levels on such a basis is manifestly unfair. Up to 1886 the mean level of the lakes was much higher than it has since been. At that time the United States Government began improving the connecting channels, and every improvement that has been made has increased the capacity of those channels and the flow through the same, and in that manner reduced the lake levels. The Government improvements in the Detroit and St. Clair rivers alone during the past fifteen years have lowered the level of the water in Lake Michigan

at least one foot. We state this not in the way of criticism, for we believe that the gain to navigation by the increase in capacity of the connecting channels is largely in excess of any loss to navigation that might be suffered by reason of a general lowering of the level of the lake. We merely call attention to the fact in order to show that it is not fair to compare the levels of the lakes during the last ten years with the levels for any period antedating such Government work. An inspection of the charts prepared by the Lake Survey Corps of the United States Army shows that the level of the lakes has varied substantially in cycles of various durations. In the ten-year period previous to the opening of the Sanitary District channel in 1900 the lowest recorded level of the lake was in 1895. Since 1900 the lowest recorded level was in 1911, and that low level was several inches higher than the low level of 1895. It would not have been unreasonable to expect that at some time within ten years after 1900 the level of the lake would fall to a point as far below the average as in 1895, but even taking into consideration the diversion at Chicago which has already occurred, such has not been the case.

Undoubtedly the concerted opposition to the application of the Sanitary District would not have arisen had it not been for the unusual low-water conditions that prevailed on the Great Lakes during the past year. These conditions were not local to the Great Lakes, but were also prevalent throughout the country. Through the lack of information by the people and interests affected, this low level of the water surface of the Great Lakes has been wrongly attributed to the diversion of water by the Sanitary District. The condition during the past year has undoubtedly been caused by the lack of rainfall.

By consulting plate 22 of the International Waterways Commission Report, on the regulation of Lake Erie (1910) it will be found what has been the loss of level due to the flow of water through the drainage canal. The average stage of lakes Huron and Michigan in 1911 was over six-tenths of a foot (7¼ inches) lower than in 1910.

The chart prepared by the United States Lake Survey referred to by me, shows that from May, 1911, when Lake Superior was at its lowest stage for the year, it had risen so that on January 1 of this year it was practically one foot and three-tenths higher than in May, 1911. During the same period Lake Michigan has only risen about two-tenths of a foot. This can only be accounted for by the fact that the

United States Government, in the construction of the new Soo locks, has lessened the capacity of St. Mary river above the rapids by means of coffer-dams, &c. The effect of this has been to store the waters in Lake Superior, which naturally would have flowed into Lake Huron, and it is estimated that if this flow had not been interfered with, lakes Michigan and Huron would probably have been in the neighbourhood of three inches higher at the present time than they are.

The effect of diverting a certain amount of water from Lake Michigan, by way of the Chicago Drainage canal, upon the Great Lakes is a subject that has received the attention of all those who have made a study of the levels of the Great Lakes. To indicate the different results obtained, attention may be called to the estimates given in the report upon the Chicago Drainage canal by the International Waterways Commission (1907), page 7, wherein the effect of the withdrawal of 10,000 cubic feet from Lake Michigan at Chicago upon the St. Lawrence river at Rapide Plat is stated as four-tenths of a foot. This is approximately 4¾ inches.

The brief submitted by the Dominion of Canada, to which is affixed the signatures of the engineers who prepared the data therein contained, gives the effect at the same point, of the same diversion, as 6.8 inches. This is a difference of nearly 50 per cent. and is a fair indication of the lack of accuracy with which compilations can be made as to the effect of a diversion from a given body of water. Generally no two engineers figuring upon this effect arrive at the same result. This is to be expected by reason of the unknown quantities entering into the computation, and also because in making the computation the data obtained by the Lake Survey cannot all be used, and the results must vary according to the data that may be utilised.

Counsel for the Dominion of Canada and those representing the vessel interests claim a granting of the permit will result in great damage to the harbour of Montreal. It is claimed that the water surface will be lowered 10½ inches. How these figures were arrived at, it is difficult to tell, as they seem to be at considerable variance with the report of the International Waterways Commission. The improvement of the St. Lawrence river between Montreal and Quebec was completed in 1906—six years after the opening of the drainage canal. In the report of the Department of Marine and Fisheries for 1910 it is stated: "At the present time a splendid channel of 30 feet at extreme low water exists from Montreal to Cap

à la Roche and to Quebec, by taking advantage of the tide." Whatever effect there is upon the St. Lawrence river by the withdrawal of water through the Chicago Drainage canal would have been felt before 1906, and the only additional lowering would be that caused by a greater diversion of water at Chicago since 1906, which is inappreciable.

On chart No. 2483 of the Canadian government charts of the harbour at Montreal, which are on file in the hydrographic office in the Navy Department, there are shown soundings of the harbour at Montreal, showing depths varying from 30.6 feet to over 41 feet. On this chart is the following: "The river (referring to the St. Lawrence) has a very great annual fluctuation and is usually at its highest about the second week in May and at its lowest from about the middle of September to the end of November. Its average height above the datum (low water of 1897) is, in May, 8 feet; June, 6 feet; July, 4¾ feet; August, 3¼ feet; September, 2¼ feet; October, 1¾ feet; November, 2¾ feet." So that with a channel dredged to 30 feet below the low water of 1897 there is ample water for vessels of 30 feet draught, and with a river having such great fluctuations due to natural causes it would be difficult, if not impossible, for navigators to notice any effect of the diversion at Chicago upon the St. Lawrence since 1906.

According to the Forty-third Annual Report of the Department of Marine and Fisheries of Canada of 1910 the total expenditures on the improvements of the St. Lawrence river since 1851 by all public appropriations has been $11,400,000. This is practically the amount that has been expended by the Sanitary District alone in the improvement of harbour facilities in the Chicago river.

Navigation interests represented by a government that has expended in their behalf less than one-sixth of the money expended by the Sanitary District for health and sanitation should not expect their protests to be seriously considered.

Objection is made by some of the gentlemen who presented arguments in opposition that it was unfair to argue that transportation companies must accommodate themselves to the natural conditions regarding fluctuations in lake levels, and that the argument presented by me in that respect is fallacious. Let us consider whether or no there is any fallacy in the arguments relating to navigation.

The only vessels now sailing the Great Lakes which could be affected by any variation in lake levels of from three to five inches are owned and operated by the ore-carrying com-

panies, particularly the Pittsburg Steamship Company, which is a subsidiary company of the United States Steel Corporation.

Mr. Livingstone, in his arguments, bases his calculations of the loss of carrying capacity upon boats 600 feet in length, and asserted that they averaged 113 tons per inch of draught, and 22 trips per season. This would result in a loss of tonnage of 2,486 tons per inch of draught. The lake survey chart submitted to you shows that the average level of lakes Huron, Michigan and Erie during the navigable season of 1910 was approximately six inches lower than the level of the same lakes during the same period in the year 1909.

On page 4833 of the printed record of the hearings had before the committee on investigation of the United States Steel Corporation (No. 54, March 11, 1912) is given a statement showing the operations of the Pittsburg Steamship Company for the year 1910. It appears from the testimony taken at that hearing, and on that day, that 30 per cent. of all the ore carried on the Great Lakes was transported by this company. The capital stock of the company, as appears from the statement referred to, is $7,880,000. The net profits of the company for the year 1910, after making deductions for interest charges and liberal deductions for depreciation, extinguishment funds, bond sinking funds, extraordinary replacements, &c., were $2,520,482.92. This is a profit of 32 per cent. upon the capital stock. It is our understanding that the year 1910 was not a year of unusual activity, but, on the contrary, was characterized by periods of business depression which were in some quarters regarded as unusual. We have not at hand the statement of the company for the year 1909, when they had available an average of six inches more water during the navigation season; but can it be reasonably contended, and can it be expected that any weight can attach to the argument that if a beneficent Providence had provided the same amount of water in 1910 as was provided in 1909, increasing the depth of water in the Great Lakes six inches, that the profits of the Pittsburg Steamship Company would have increased in the manner and to the extent indicated by the argument of Mr. Livingstone? If this were true, each boat would have had an increased tonnage of 14,916 tons. It appears from the testimony of the secretary of the Pittsburg Steamship Company, in the litigation now pending between the United States Government and the Sanitary District, that that company operates 73 boats having a draught of 19 feet

or more. This would mean a total difference in tonnage of 1,880,868 tons, and in the testimony of Mr. Freer before the investigation committee referred to above, it appears that the average freight rate charge was 65 cents a ton; so that the total increased receipts of this company alone, following such a line of reasoning, would have been $707,764.20 greater in 1910 had the level of the waters of the Great Lakes remained in substantially the same condition as during the year 1909. This would increase the profits of this company by approximately 9 per cent. It may be suggested in passing that if the public has received any benefit in the reduction of the price of steel by reason of these enormous profits, that benefit is not apparent to the casual examiner. The price of steel rails, as we are informed, has remained constant since the organization of this corporation.

We make these observations to show the character of the arguments presented against us, and the claims of those who make them, upon the protecting arm of the National Government, when brought into conflict with the higher function of government, in the preservation of human life and the promotion of the general welfare.

These suggestions are also submitted for the purpose of calling attention to the fallacy of the whole case presented by those who oppose our application on the ground of the loss of profits to the navigation interests. The fallacy lies in this, that the profits of the transportation companies depend, not upon depth of water, but upon the amount of freight carried. It is not and cannot be truthfully contended that any freight has not been carried by reason of lack of water which otherwise would have been. The commerce of the Great Lakes consists of a certain tonnage each year, and that tonnage is accommodated and cared for. The profits earned depend upon the volume of business and the rates charged. It is a well-known fact that it is more economical to use the deep-draught vessels, even when not loaded to their fullest capacity, than boats of the older type, and this is evidenced by the hundreds of boats lying idle in the ports of lakes Erie, Huron, and Michigan because they have been superseded by boats of modern type.

The present diversion from Lake Michigan at Chicago through the Chicago river is limited to 4,167 cubic feet of water per second. This limitation was placed upon the Sanitary District not because of any effect on lake levels or lake commerce, but in order to protect the Chicago river from an

excessive current. It is true that at certain times there has flowed through the Sanitary District channel and over its dam at Lockport a volume of water largely exceeding this amount, but regard has always been had to the maintenance of a safe current in the Chicago river. General Bixby, in his report quoted to you, asserts that the average amount now used by the Sanitary District is 7,000 cubic feet of water per second. This is more than the usual flow. But assuming that that statement is true, has any one appeared who has made the slightest claim that up to this date navigation has been injured by the operation of the Sanitary District canal? The contrary seems to be abundantly established. Every man conversant with navigation on the Great Lakes knows that during the past ten years the vessels that have been built have been built with larger capacity and deeper draught than ever before, and the tonnage now handled on the Great Lakes is greater than ever in the history of navigation in the United States. Why, then, this great fear that an additional grant of authority to use that which is necessary to preserve human life will bankrupt the transportation companies of the country?

According to the computations made by the International Waterways Commission, the effect upon the levels of Lakes Huron and Michigan of the diversion of 3,000 cubic feet of water per second in addition to that now taken would be 1.25 inches, and in the St. Lawrence river 1.40 inches. It must be borne in mind that even conceding 7,000 cubic feet of water per second has been withdrawn from Lake Michigan by the Sanitary District, such concession is not an admission that the permit heretofore issued by this Department has been violated, for, as already pointed out, none of the permits in any way limited the amount of water to be diverted from Lake Michigan. They were directed solely to the amount of water that should be taken through the Chicago river, the purpose being to maintain navigation on that river and prevent an excessive current. As already stated, 2,000 cubic feet is capable of being withdrawn through the Thirty-ninth street conduit entering the river practically at the beginning of the canal. This amount, added to the 4,167 cubic feet authorized to flow through the Chicago river, makes a total of 6,167 cubic feet per second, and in addition to this there is a considerable flow through the canal of water

withdrawn from the lake through the cribs and pumping stations used in the maintenance of the city's water supply.

As I attempted to show in the oral hearings, Chicago is itself interested in the maintenance of navigation and commerce, and will do everything in its power to protect them. No community in the United States and no port on the Great Lakes is more desirous of encouraging the activities incident to lake commerce. We merely feel we should be entitled, at least until it has been demonstrated that our works are injurious to the interests of navigation, to have the health and lives of our people protected.

The subject of the effect upon lake commerce of the diversion of water through the Sanitary Canal has been discussed many times and by many eminent engineers in the employ of the Government. It should be borne in mind that this work was not undertaken without thorough knowledge on the part of every well-informed engineer and official of the United States, and it seems strange that, after the successful operation of more than twelve years with no bad effects yet noticeable from such operation, the benefit of the tremendous expenditure made by the people of Chicago should be denied because of fears as to future effects not borne out by past experience.

The effect of the diversion of 10,000 cubic feet of water per second has been calculated with a great deal of care by the engineers in the Lake Survey. If all the theories can be relied upon, the observations are accurate, and calculations fairly made, it is probable that such a diversion would be theoretically determined as affecting the level of Lake Michigan to the extent of about five inches.

I do not wish to question the accuracy of the figures or the fairness of the calculations, but in view of the actual conditions existing in the lakes during the past ten years, I am constrained to say that I believe that there are unknown quantities and unknown conditions affecting lake levels which have not yet been determined or appreciated. The fact is indisputable that with a constant diversion through the Sanitary channel since January 17, 1900, the average level of Lakes Michigan and Huron was higher during the ten years immediately following than it was the ten years immediately preceding the opening of the channel. Of course it is immediately stated in answer to this, that this rise in lake levels was due to natural conditions, rainfall, &c. But it is equally true that the abnormally low

condition of the lakes during the past year and at the present time is also due to the same natural conditions,—rainfall, &c. In all the arguments presented to you the basis of the complaints of those who oppose our application seems to be a diversion of 10,000 cubic feet. It was asserted that we are already withdrawing from Lake Michigan from 4,000 to 7,000 cubic feet of water per second, yet not a single complaint is made, not a suggestion offered, that up to this time navigation has been injuriously affected. Why then the fear that the additional water asked for would bring such a calamity to the interests of commerce and navigation?

Chicago River Navigation.

Objection is made by some of those who appeared before you that the granting of the permit in question will injuriously affect navigation in the Chicago river. As has already been pointed out the limitations placed upon the Sanitary District do not refer to the amount of water to be taken from the lake, but have reference entirely to the conditions of that river and were imposed for the purpose of protecting navigation and preventing a current above that in which navigation may be properly conducted. The granting of the permit in question will increase the flow through the Chicago river eventually by 2,000 cubic feet of water per second. That is to say, of the 10,000 cubic feet of water to be withdrawn from Lake Michigan, 6,000 feet will eventually flow through the Chicago river, 2,000 through the Thirty-ninth street conduit, and 2,000 through the Calumet-Sag channel now in course of construction. In order to protect the interests of navigation, and in order to prevent a current injurious to commerce, the Sanitary District has acquired property adjoining the river, paying therefor nearly $5,500,000; has expended in dredging the river to a depth of 26 feet approximately $2,500,000; has removed centre-pier bridges and constructed in lieu thereof bridges of the bascule type with wider openings at the aggregate cost of over $3,000,000.

The project undertaken by the Sanitary District involves the widening of the river to a uniform width of 200 feet and dredging to a depth of 26 feet. This project is now practically completed except at those points where the work is delayed pending a decision by you of controverted questions of law and fact in relation to the removal of certain

bridges. The grand total of the sums of money expended by the Sanitary District up to this time in the improvement of that river and in the protection of navigation interests amounts to $11,437,820.69. This is an ample guarantee that the Sanitary District is safeguarding the commercial interests of the port of Chicago, and is doing all in its power to see to it that navigation will not be interfered with nor the interest of her Canadian friends injuriously affected. As pointed out in another part of this brief, the amount expended on this project alone exceeds the total amount expended by all public bodies of the Government of the Dominion of Canada in the improvement of the St. Lawrence river since 1851.

The improvements herein referred to provide for a flow of 6,000 cubic feet of water through the Chicago river, with a current not to exceed one mile per hour, and it is generally conceded by the navigation interests that a current of a mile and a quarter, as now permitted, is safe and not such as to create any hardship upon those seeking to use this waterway. At the time the first permit was issued by the Secretary of War, in 1889, the Chicago river was obstructed by centre-pier bridges, was narrow and shallow, and in some places its width did not exceed 90 feet and its depth did not exceed 16 feet. Navigation was interfered with, not only by the bridges and the narrowness of the channel and the shallowness thereof, but by tunnels constructed by the street railway companies and the City of Chicago, which have been removed in order to fully carry out the project of the Sanitary District for the improvement of the river and providing for the flowage necessary to purify the sewage. These considerations have to do, of course, only with navigation and commerce. We cannot, however, forbear again reverting to the fact that a still greater public benefit has come from changing the river from a putrid, ill-smelling nuisance into a clear, running stream which is no longer an eyesore or a menace to the inhabitants of the city.

Illinois Valley.

Protests have been filed against the granting of this permit largely conditional in their nature, by the Association of Drainage and Levee Districts of the State of Illinois. The protestants who are responsible for the resolution sent by that association and by the city councils and chambers

of commerce of certain cities and towns in the Illinois valley are fully acquainted with the beneficient results flowing from the use of the Sanitary District channel for the purpose for which it was constructed. As in other cases, these protests are based on the financial injury which will result from the supposed additional flooding of their land and the increased cost in the constructing of levees and the maintenance of levee districts. Of course, it is apparent that this has nothing to do with the question of navigation to which you confined the arguments at the hearing.. Mention is made, however, of the subject-matter because the protests are conditional and are predicated upon the present existence in the river of four dams, two maintained by the State of Illinois, through the Illinois and Michigan Canal Commissioners at Henry, and Copperas creek, and two maintained by the United States Government at Kampsville and La Grange respectively. The representatives of these associations were present in Chicago prior to the hearing on the 27th ult., and expressed themselves as perfectly satisfied with the progress being made toward the removal of these dams, and they concede that if the dams are removed their protests should be withdrawn. The State of Illinois, through its Canal Commission, has already taken action which will permit the Sanitary District, at is own expense, to remove the State dams. A bill has been introduced in Congress to remove the Government dams at Kampsville and La Grange, which so far has aroused no opposition. The only excuse for the presence of these dams was to maintain a sufficient depth of water in the Illinois river to provide for navigation by boats having a draught of seven feet. All agree that with the water now being sent to the Illinois river through the Sanitary District canal this depth can be maintained without the presence of the dams. We apprehend that there will be no difficulty in removing these dams before the full amount of water asked for is abstracted from Lake Michigan, and the removal of the dams will afford a channel of sufficient capacity to accommodate the flow of all the water asked for with less damage to the adjacent property owners than is caused by the present flow. I think I may say without fear of contradiction that had the progress which has been made toward the removal of these dams been made some months ago no protest would have come from this source, but, on the contrary, the application would have been endorsed and the co-operation of

the protestants would have been assured to us in the pending matter.

Rights of the Dominion of Canada under the Treaty of January 11, 1909.

A large part of the argument submitted by the Dominion of Canada consists of an attempt to ingeniously argue that by reason of the treaty between the United States and the Dominion of Canada, signed on January 11, 1909, the Dominion Government has a right to have a voice in the question as to the amount of water that shall be diverted from Lake Michigan for sanitary and domestic purposes.

With the proposition that the United States Government should at all times, as a matter of comity, listen to all protests and arguments that may be submitted by a neighboring friendly government against any exercise of its governmental functions, and that the same policy should be pursued by the officers entrusted with the administration of the laws of Congress, I have no quarrel. No complaint can be made, and none is here suggested, that the Dominion authorities and the Canadian interests were permitted to state their views freely in connection with the subject-matter pending before your. This opportunity, however, was a matter of comity and courtesy, and not a matter of right; and the opportunities thus afforded are not based upon any provisions of the treaty in question.

Counsel for the Dominion Government admits that Lake Michigan is not included within the definition of boundary waters as contained in the treaty. This lake is entirely within the territorial limits of the United States, and it would have been inappropriate to have included it within the term "boundary waters." This was recognized in the treaty itself, and the only rights given to Canada on Lake Michigan are those conferred by the second paragraph of Article I, in which it is provided:

"It is further agreed that so long as this treaty shall remain in force this same right of navigation shall extend to the water of Lake Michigan and to all canals connecting boundary waters, as now existing, or which may hereafter be constructed on either side of the line."

It seems to us the counsel occupied a dual position in claiming that the right of Canada to navigation was based upon the clause above quoted, thus admitting that, so far as

navigation was concerned, Lake Michigan was not a boundary water as defined in the treaty, and at the same time urging that Canada had a right to have a voice in the manner in which the waters of Lake Michigan should be used for sanitary and domestic purposes, on the theory that it is a boundary water as defined in the treaty.

There can be no question but that Lake Michigan was intentionally omitted from the provisions of the treaty; and this was proper. There was no reason why the United States should abandon its dominion over, and control of, a body of water lying entirely within its own boundaries. An examination of the record of the negotiations leading up to the adoption of the treaty will disclose that the subject-matter was discussed and that it was the intention of the parties to exclude this body of water from its provisions.

The right of those interested in navigation in Canada to protest against any diversion of water from Lake Michigan is not based upon this or any other treaty, but stands upon the same footing as any individual who is permitted to express his views to one charged with the performance of an official duty.

So far as the government of Canada itself is concerned, it is *expressly precluded* from entering any protest in this proceeding. Even assuming, for the sake of argument, that the government of Canada, as such, is entitled to have any voice as to the use to which the waters of Lake Michigan shall be put, that Government has bound itself by the terms of the treaty itself to refrain from protesting against the use of waters for domestic and sanitary purposes if the only purpose of such protest is to protect navigation. If the right of the citizens of Canada to navigate Lake Michigan should be exercised by those citizens to the detriment of sanitation, and such use should interfere with the use of the waters of Lake Michigan for domestic and sanitary purposes, then the Government of Canada would be guilty of violating the terms of the treaty.

Article VIII of the treaty expressly provides as follows:

"The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:

"1. Uses for domestic and sanitary purposes.

"2. Uses for navigation, including the service of canals, for the purposes of navigation.

"3. Uses for power and for irrigation purposes.

"The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boundary."

It has been a matter of some surprise, in view of this definite and positive provision in the treaty as to the order of precedence to be observed in the uses to which the waters of the Great Lakes shall be put, that the Government of Canada should appear protesting against the use of the waters of Lake Michigan for sanitary and domestic purposes, on the ground that navigation will be interfered with. Some attempt is made to escape from the plain and natural interpretation of the words above quoted by calling attention to the last clause of Article III of the treaty.

The last paragraph of Article III is intended to guarantee to each Government the right to carry on its own works on its own side of the boundary line; and the last clause provides as follows:

"Nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes."

Because of the use of the word "ordinary" in this clause, counsel would insert it into Article VIII above quoted, making the first and paramount use to which the waters of the Great Lakes may be devoted "ordinary uses for domestic and sanitary purposes."

Manifestly, this was not the intention of the framers of the treaty. This is evidenced, first, by the fact that the word "ordinary" was not used; second, because it is expressly provided that the provisions shall not disturb any existing use of boundary waters on either side of the boundary; and if, under any construction, Lake Michigan could be construed as a boundary water because of its connection with Lake Huron, the Canadian Government had full notice of the fact that the waters of Lake Michigan were at the time of the signing of the treaty, being used for the purpose of diluting the sewage of the City of Chicago; and they consented that no provision of the treaty should interefere with that use. If the water of Lake Michigan is to be used to dilute the sewage of Chicago, a sufficient quantity thereof must be appropriated for that purpose, and the Canadian Government was fully aware of the plan for the treatment

of sewage which had been adopted and carried out by that city.

Counsel for the Dominion, as well as the representatives of the navigation interests, were careful to reserve the right to protest hereafter under the terms of the treaty, and called attention to the last paragraph of Article II, as follows:

"It is understood, however, that neither of the high contracting parties intends, by the foregoing provision, to surrender any right which it may have to object to any interference with or diversion of waters on the other side of the boundary, the effect of which would be productive of material injury to the navigation interests on its own side of the boundary."

This clause was not inserted for the purpose of giving either Government any right not already enjoyed by it. The right of one nation to protest against acts of another, which may be detrimental to the integrity of the nation or the interests of its inhabitants, is founded not upon treaties, but upon the general principles of international law; and this clause merely means that those general rights were not to be construed as having been taken away by the treaty, and it was not intended that the treaty should give them additional rights.

It may be here observed that a protest from the Dominion of Canada gainst the lowering of lake levels comes with rather poor grace. It is a matter of record in your department that during the improvement of the Detroit river in the construction of the Livingstone channel the United States Government sought to maintain the level of the lakes by the construction of remedial works on the Canadian side. A protest was entered on behalf of the Canadian Government, and those remedial works have not been constructed as was planned by the United States engineers.

The rights of the Dominion of Canada and the obligations of the United States arising under this treaty, in so far as the control of the waters of Lake Michigan is concerned, would be decided adversely to the Dominion Government, according to the principles of law that are clearly set forth in the opinion of Hon. Judson Harmon, Attorney General in 1895, rendered to the Secretary of State construing the treaty of Guadalupe-Hidalgo (Opinions of Attorney General, volume XXI, page 27).

On page 30 of the brief submitted by the Dominion of Canada this statement appears:

"Chicago is at the stagnant end of what is practically a stagnant lake, fed only by small streams, nearly all of which discharge into it the sewage of a large and rapidly increasing population, and the drainage wastes of large and growing industrial establishments."

This statement is surprising in its inaccuracy. The engineers in your department will inform you that, if Lake Michigan were a stagnant lake, Chicago would be at the headwaters of the watershed. It is well known that the waters of Lake Michigan are more potable than those of any of the Great Lakes, except Lake Superior, and, except in the vicinity of large cities which may be permitted to discharge their sewage into it, is a source of an abundant and exceptionally good supply of drinking water.

Compensating Works.

In view of the great importance to the people of Chicago that the request now made be granted, we have made some study of the question of the cost of such compensating works as might be necessary to nullify any effect of a diversion through the Sanitary District canal if such effect should be deemed injurious to navigation. This subject is one which requires great study and elaborate computations. It has been a subject which has been given consideration by many of the most eminent engineers of the country; and, bearing upon the general proposition of the practicability and efficacy of such works, I have the honor to attach hereto as an appendix, marked "C," a letter from Alfred Noble, of New York City, who is recognized as one of the most eminent engineers of the country.

I suggest, also, that Mr. Noble by his letter endorses in large degree the report of the Chief Engineer of the Sanitary District, to which reference has been made.

Conclusion.

We respectfully submit that it is abundantly shown:

1st. That there is an imperative need of the waters of Lake Michigan for sanitation purposes, as specified in our application.

2d. That the Sanitary District canal is the outgrowth and development of a scheme recognized by the United States

Government, the Dominion of Canada, and the State of Illinois since 1822.

3d. That we are entitled, as a matter of right, to the use of so much of the waters of Lake Michigan as may be necessary for sanitary and domestic purposes.

4th. That no substantial injuries have been shown to have been suffered by navigation interests in the past, and that the fears of future damage are too indefinite to weigh against the pressing needs of sanitation.

5th. That navigation in the Chicago river will be abundantly protected by such restrictions as may properly be imposed by the War Department.

6th. That the conditional protests of the associations and cities in the Illinois valley were based upon conditions that are already being eliminated.

7th. That the Dominion of Canada has no right under the treaty of January 11, 1909, to any voice in the disposition of the waters of Lake Michigan for sanitary purposes.

8th. That, even if it shall be possible in the future to care for the sewage of the Sanitary District without the use of the additional water asked for, the permit should be issued until such conditions arise, when the permit may be appropriately revoked or altered.

We agree with one of the eminent gentlemen who spoke on behalf of the Canadian Water Power Company, when he said that the question to be decided in this matter is a momentous one and of supreme importance.

It is a question as to whether or not fears shall be allowed to prevail over facts, and whether or not possible profits to navigation interests shall be considered of greater importance than the lives of the people of a community comprising one-thirtieth of the population of the nation.

We feel confident that the decision will be in the interests of humanity, and that the public interest will be protected and the general welfare promoted.

Respectfully submitted,

John C. Williams,

Attorney for Sanitary District of Chicago.

Approved:

George M. Wisner,

Chief Engineer.

REPLY ON BEHALF OF CANADA.

In the Matter of the Application of the Sanitary District of Chicago for a Permit to Divert not to Exceed Ten Thousand Cubic Feet of Water per Second for Sanitary Purposes from Lake Michigan.

To the Honourable Henry L. Stimson,
Secretary of War.

Sir:—Replying to the brief, or suggestions, in behalf of the Sanitary District of Chicago filed by John C. Williams, Esquire, Attorney for the Sanitary District, it is respectfully submitted:—

That, while professing to confine himself as closely as possible to the suggestions conveyed in the course of the hearings before you, that the sole purpose of the enquiry was to decide whether, or not, the interests of navigation would be substantially affected adversely by the granting of the permit, the learned Counsel departs widely from this ground and dwells at great length upon the needs of Chicago with regard to sanitation. Indeed he seems to treat the question of injury to navigation very lightly, as if it were of but slight importance, instead of being, as it is, the sole question which you are called upon to determine on this application. It is not, as the learned Counsel for the Sanitary District suggests, that the protection of navigation interests would be rendered MORE profitable, but it is because navigation interests will not only be rendered enormously LESS profitable, but, that great expenditures amounting to over $18,000,000, at least, on the Canadian side of the line, will become necessary to restore the lost depths in Canadian harbours,—including the great national port of Montreal, the ship channel and the Canadian canals—that it is urged in behalf of the Canadian government, that the proposed diversion will be productive of material injury to navigation interests on the Canadian side of the boundary. It goes without saying that navigation interests on the United States side of the boundary will suffer injury in like manner, but, admittedly, to far greater extent in respect to the effect on shipping. It is abundantly clear that the navigation interests of both countries are not only seriously threatened by the proposed diversion but have already sustained material injury by the reduction of the levels of the great international waterways

system. This is manifest from the expert evidence of competent witnesses on both sides of the line including the United States Corps of Army Engineers, and the technical officers of the Canadian Government, as well as many eminent private engineers whose statements are before you.

By the Federal constitution, navigation is confided to Congress, hence it is submitted, the Legislature of the State of Illinois could not legally authorize the diversion of the waters of Lake Michigan, the effects of such diversion being manifestly productive of material injury to navigation.

In the absence of legislation on the part of Congress authorizing the diversion of the waters of Lake Michigan it is submitted, that, unless the Sanitary District obtains a permit from the Secretary of War authorizing such diversion, under Section 10 of the Act of Congress of March 3, 1899, by which the Secretary of War is given jurisdiction over the navigable waters of the United States, it is contended, that the claim set up in the brief of the attorney for the Sanitary District that they are entitled to use the waters of Lake Michigan as a matter of right, is not well founded.

The jurisdiction of the Secretary of War extends over all navigable waters of the United States and any injury to navigation within the territory of the United States is cognizable by him, so that, if the lowering of the levels of the waters of Lake Michigan and boundary waters within United States territory be productive of material injury to navigation, it is a matter that comes within the jurisdiction of the Secretary of War. That the lowering of the levels of the lakes, connecting channels, and canals, entailing heavy permanent losses to navigation interests, will occur as a direct result of the proposed diversion, is established beyond question in the brief filed on behalf of the Canadian Government and in the other statements filed on the part of Canadian interests, as well as by the International Waterways Commission report, and the report of the United States Corps of Engineers which is signed by General W. H. Bixby, Chief of Engineers, United States Army, dated January 23, 1911, wherein it is stated "As the water which is at present being diverted from the lake appears to have already seriously affected the navigation of its harbours and connecting waterways, prompt congressional action is recommended to limit the diversion."

It is not the desire, nor is it the intention of Counsel for the Canadian Government to reiterate the arguments put forward in the brief filed by him on the 27th of March, nor

to repeat anything that was urged, orally, on that occasion in opposing the granting of the permit asked for. This reply will be confined as nearly as possible, to dealing with new matter and answering statements made by the Counsel for the Sanitary District in his brief filed since the last hearing. At the same time reliance is placed upon the accuracy of the statements of fact and inferences drawn therefrom, as well as the general conclusions reached, as set forth in the Canadian Government's brief. The statements herein put forward are to be treated as supplementary to the brief already filed on the part of the Canadian Government.

Counsel for the Sanitary District, in several places in his argument, endeavoured, in substance, to show that the jurisdiction of the Federal Government is limited to the effects which the withdrawal of water from Lake Michigan through the Chicago river will have upon navigation in that river. He contends that, therefore, all that is asked in the application now pending, as well as in former applications, is permission to draw water through the Chicago and Calumet rivers, and that the Sanitary District has a perfect right to draw without permit any quantity of water from Lake Michigan which it may please, through channels other than the Chicago river.

We strongly protest against the assumption of any such right by the Sanitary District because the withdrawal from Lake Michigan of water through any channel and the diversion of the natural flow of the Chicago and Calumet rivers to the Mississippi instead of to Lake Michigan, have precisely the same effect of lowering the level of Lake Michigan and, consequently, to lower Lake Huron and all other bounary waters between Sault Ste. Marie and the tidewaters of the St. Lawrence; and, thereby, to affect adversely the navigation interests of both the United States and Canada throughout the whole extent of these waters. To that extent, such withdrawal is a violation of the Treaty of 1909.

The permit of May 8, 1899, recites that, whereas, the Sanitary District had been granted permission by the Secretary of War to enlarge the Chicago river so as to secure a flowage capacity of 300,000 cubic feet per minute, "it being intended to connect the said artificial channel (from Chicago to Lockport) with the west fork of the south branch of Chicago river at Robey street," the Secretary of War "hereby gives permission to open the channel constructed and cause the waters of Chicago river to flow into the same."

The permit of April 9, 1901, reduces the permitted "discharge from the river into the drainage canal."

The permit of December 5, 1901, increases the discharge permitted during certain hours of the day.

The permit of January 17, 1903, gives "permission to increase the flow through the Chicago river" until March 31, 1903.

The water pumped at Wilmette flows down the north branch of the Chicago river to its confluence with the south branch and thence along the channel of the latter to the head of the Drainage Canal at Robey street. The water pumped at the 39th street pumping station flows by the south branch of the Chicago river to the head of the Drainage canal at Robey street.

It is submitted that the permit of May 8, 1899, is the basal authorization for all diversions; that it authorizes the opening of the Drainage canal at Robey street; that it distinctly applies the name "Chicago river" to the channel from Lake Michigan to the head of the Drainage canal at Robey street; and further, authorizes the discharge into said canal of a specified amount of water. Later permits are simply modifications of the amount of water authorized to be discharged into the canal.

Counsel argues that the discharge from the Wilmette and 39th street pumping stations, the water pumped for domestic water supply and, inferentially, any other flowage not discharged into the Chicago river below the confluence of the north and south branches, do not come within the purview of the above mentioned permits. It is submitted, that this argument is absolutely untenable. It is further submitted that the discharge of the Sanitary canal at Lockport cannot legally exceed the amount authorized by the Secretary of War.

The fact that the permits heretofore granted specifically guard the interests of navigation in the Chicago river, does not preclude navigation interests elsewhere which are adversely affected by the diversion through the Chicago Drainage canal from protesting against the granting of the permit now asked for. It was only when it was found that the diversion already permitted was reducing the levels of the Great Lakes and connecting channels and canals, thereby causing material injury to navigation, that navigation interests on both sides of the border acting with a common impulse but without any preconcerted arrangement, joined

forces in vigorous protest against the granting of the present application.

As far as Canada is concerned in the question of joining in the concerted opposition to the proposal, it may be stated that this is the first occasion on which she has been invited to express her views. All previous permits were granted without reference to Canada. It is not in accordance with the facts to state that this concerted action is due to the unusual low-water conditions of the past season. On the contrary, it is due to the request of Chicago for more water. Against the unanimous action on the part of navigation interests, supported by the Dominion Government and butteressed by unquestionable data from unimpeachable sources, in protesting against any further diversion of the waters of Lake Michigan because of the injury to navigation, we have the bald statement of counsel for the Sanitary District that "the objection to the granting of the permit made by those who are interested in lake navigation is based upon fears for which there is no basis, and upon speculative theories that up to this time have not been demonstrated to be of practical force."

Referring to the statement of the learned Counsel for the Sanitary District that Counsel for Canada admits that Lake Michigan is not included within the definition of boundary waters as contained in the treaty, attention must be called to the various other references which were made during the hearing by Counsel for Canada, in which that admission was very much qualified, and a reservation of Canada's rights to have the question referred to the International Joint Commission was made by Counsel for Canada, not only in his oral statement, but in his brief filed with you.

Dealing with the rights of the Dominion of Canada under the Treaty of January 11, 1909, Counsel for the Sanitary District observes that "so far as the Government of Canada is concerned, it is expressly precluded from entering any protest in this proceeding."

Whether or not Lake Michigan may be considered a boundary water within the definition of the treaty, it cannot be questioned that the right of navigation of Lake Michigan is conceded to Canada while that treaty remains in force. If, therefore, the right of navigation of Lake Michigan on the part of Canada is obstructed in any way, as for instance by the diversion of waters from Lake Michigan through the Chicago river causing an increased current

and thereby rendering navigation of the Chicago river hazardous, Canada would be entitled to enter a protest. If Lake Michigan is a boundary water, or might so be considered under the spirit of the treaty, Canada would not be debarred from protesting against the proposed diversion, since, as it is submitted, that, by the true construction of Article VIII of the treaty defining the order of precedence, "uses for domestic and sanitary purposes" means "ordinary use." To hold that these words mean an extraordinary use such as the diversion at Chicago through the Drainage canal causing an irreparable loss to navigation, would defeat the object of the treaty which was the protection of boundary waters, while, in the first place, recognizing the right of either country to the ordinary use of boundary waters for domestic and sanitary purposes, and, secondly, "uses for navigation, including the service of canals, for the purposes of navigation." If by the first use for domestic and sanitary purposes it was contemplated that such a diversion could be made as would seriously impair navigation, it would be a violation of the spirit of the treaty.

Counsel for the Sanitary District goes so far as to state that "if the right of citizens of Canada to navigate Lake Michigan should be exercised by those citizens to the detriment of sanitation, and such use should interfere with the use of the waters of Lake Michigan for domestic and sanitary purposes, then the Government of Canada would be guilty of violating the terms of the treaty." It seems unnecessary to reply to such an extreme and unwarranted statement; but, as counsel has devoted considerable space to this point, it may be well to state that, while priority in the use of waters is set forth in the treaty, yet it was never intended that this priority was to work injustice to other legitimate users of the waters.

Counsel's argument is, in brief, that the treaty of 1909 permits the unlimited diversion of water so long as it is required for "domestic and sanitary purposes." The logical deduction, therefore, is that, if so required, the whole flow of Lakes Huron and Michigan could be diverted and the St. Clair river dried up—the *reductio ad absurdum*.

The principle affirmed in Article III is, that there shall be no uses, obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line except by the authority of either country within their respective jurisdictions. Exceptions are made in favour of

governmental works for the benefit of commerce and navigation, provided such do not materially affect the level or flow of the boundary waters on the other side. Here, again, the principle of maintaining the levels of boundary waters is apparent.

And finally we have the concluding clause quoted by the learned counsel "nor are such provisions intended to interfere with the ORDINARY USE of such waters for domestic purposes." What waters are here referred to? The answer is clear and simple: boundary waters. Yet Counsel for the Sanitary District endeavours to draw a distinction between the use of boundary waters for domestic and sanitary purposes as contained in the final clause of Article III, and the use of boundary waters in Article VIII, wherein the object is only to give the order of precedence in the several uses of boundary waters. It is respectfully submitted that Article III explains the meaning of the words in Article VIII, giving precedence to the "uses of boundary waters for domestic and sanitary purposes" and clearly shows that such uses are only "ordinary use."

To put the construction contended for by the learned counsel on Article VIII, and to hold that "uses for domestic and sanitary purposes," leaves such uses unrestricted, would be contrary to the letter and spirit of the treaty; whereas the use of boundary waters as provided for in the concluding clause of Article III, that is to say, "ordinary use" puts a reasonable construction on the language in Article VIII. Then again, the first mention of the use of boundary waters for domestic and sanitary purposes in the treaty is in Article III, and the words there employed, "ordinary use," show unmistakably what the framers of the treaty had in mind in giving precedence to the use of boundary waters for domestic and sanitary purposes in Article VIII. In other words, Article VIII does not enlarge the clearly expressed definition of the use of boundary waters for domestic and sanitary purposes in Article III, i. e., *ordinary use.* No significance can be attached to the omission of the word "ordinary" in Article VIII. The extent of the use had been already defined in Article III.

The foregoing is sufficient to demonstrate that the treaty contemplated only the "ordinary" use of water for these purposes and had reference to its abstraction by pumping for domestic and sanitary use and contemplates its use as a diluting agent when sewage is discharged into it. Additional weight is lent to this contention by the last paragraph

in Article III above quoted. However, a discussion of this branch of the case is not really pertinent to the question you have undertaken to determine.

The boundary waters treaty was conceived with the express purpose of conserving the integrity of the levels of the Great Lakes. It was not an object of the treaty to establish the priority of agency by which these levels might be disturbed, but rather than when once it has been decided by both countries that certain usages of water were for the common and general good, then the treaty provides for the priority of those uses. Any use of water, therefore, must, itself, first be approved and sanctioned by the two countries party to the treaty.

From the learned counsel's argument it would appear to one unfamiliar with the circumstances, that the Sanitary District was already, in the possession of rights under the treaty of 1909, to make the diversions in question. A wholesale diversion of water, such as is proposed by the Sanitary District, is a question which must be decided by the proper tribunal before any ground for considering priority of use would be created.

The learned counsel, on the theory that Lake Michigan is not a boundary water as defined in the treaty of 1909, contends that Canada has not a "right to have a voice" in the manner in which the waters of Lake Michigan should be used for domestic and sanitary purposes. Canada, however, declares that she has treaty rights in respect to diversions from Lake Michigan because such diversions directly affect boundary waters. Diversions from the lower end of Lake Michigan mean the taking away of waters which in their natural channels, would flow into boundary waters, and this taking away of such waters materially affects lake levels and results in serious injury to navigation and other interests on the Canadian side of the boundary. Indeed, this is also the ground taken by the special Board of Engineers under the chairmanship of Brig.-Gen. W. H. Bixby. In its report of January 23, 1911, to the U. S. Secretary of War, this Board states:

"The future diversion of water from Lake Michigan for any purpose is fraught with difficulties. *Not only has Canada an interest in the maintenance of lake levels which the United States must recognize,* but every foot of water flowing through the Chicago Drainage canal lessens the flow at Niagara Falls and at the power sites along the St. Lawrence river."

The learned counsel states that:
"the Canadian government had full notice of the fact that the waters of Lake Michigan were, at the time of the signing of the treaty, being used for the purpose of diluting the sewage of the City of Chicago; and they consented that no provision of the treaty should interfere with that use."

This allegation might have some force if the present application had reference to the limited use referred to. But it can be of no avail on an application for a largely increased amount, and, on such an application, in view of the restricted scope of the discussion as defined by you, Mr. Secretary, it is unnecessary to enter into any argument regarding the limited amount that might ultimately be found necessary.

Appendix "B" of the brief of Counsel for the Sanitary District quotes sections 19 and 43 of the report of the International Waterways Commission, and the argument has been advanced that this report constitutes a joint recommendation on the part of the Governments of Canada and the United States that a withdrawal of 10,000 cubic feet of water per second through the canal should be permitted.

Counsel for Canada contends that, inasmuch as it is a purely advisory body, no recommendations by the International Waterways Commission can bind either Government and that no such recommendation has been adopted by either.

II.

In the section of the brief submitted by Counsel for the Sanitary District which deals with the disposal of the sewage of Chicago the essential features of the argument are:—

(1) That there is no known method of sewage treatment which, if applied to Chicago, would make the effluent fit for being discharged into Lake Michigan near the intakes of the water works.

(2) That, therefore, the dilution method adopted for the treatment of the sewage of Chicago is the only feasible one at present known.

(3) That the 10,000 cubic feet of water per second now applied for by the Sanitary District is the least quantity by which the sewage of Chicago and its suburbs can be properly diluted and made fit for being discharged through the Drainage canal into the Illinois river.

With respect to the first contention, we reply that we have nowhere asserted or requested that the sewage of Chicago should be purified to such extent as to be fit for being dis-

charged into the lake and thus mixed with the supply for the waterworks.

We have simply asserted and maintained not by opinions, but by examples, cited, that the purification of sewage to such extent as to be non-putrescent and non-offensive, and thus made fit for being discharged into the Drainage canal and into the Illinois river, is entirely feasible.

The reports of the sanitary engineers upon the treatment of Chicago sewage, which we have quoted, bear us out in this contention.

The learned counsel himself, in his brief, admits that Chicago is so situated that it is possible by a combination of partial purification and dilution methods to dispose of its sewage without offense to any one and with perfect safety to its water supply. It is a comparatively simple and inexpensive matter to partially purify sewage.

The dilution method, or, more accurately, the power producing method, chosen by Chicago—and the one to which it so strenuously adheres—is not the combination of partial purification and dilution, which counsel and the experts of the Sanitary District admit to be quite feasible. It consists in taking the raw sewage of a prospective population of three millions, including the largest part of the industrial wastes, and demanding water enough to convert it into an innocuous stream of vast volume which is to be used for the generation of power estimated by Mr. Hering at 47,300 horse power, and then discharged into the Illinois river. It is the abstraction of this enormous quantity of water in utter disregard of navigation and other interests, to which we object, and for the reasons set forth in our former brief.

Counsel cites the case of Worcester, Mass., as one in which the treated effluent is unfit for domestic use and remarks that, if the intermittent filtration there used were adopted at Chicago, the cost of obtaining the necessary land and preparing filter beds would be so enormous as to make it prohibitive. The deductions thus drawn from the Worcester example are entirely irrelevant, because the conditions at Worcester and at Chicago are quite different, and the method which is suitable to one is not suited to the other.

The eminent engineers, Mr. Hering and Mr. Wisner in their reports show that the sprinkling system is that which is suitable for Chicago, and that it can be installed and operated at a moderate cost.

Mr. Wisner even goes so far as to indicate suitable sites by saying that "the sites available are to the north of the junction of the North Shore channel with the north branch of the Chicago river, near Lawrence avenue, on the flat tract of land which exists there. On the west side, sites seem to be available to the east of the old Ogden dam, and both north and south of the main channel. Pumping would have to be resorted to in any case. On the south side available sites in the Calumet region are many."

As regards the case of Manchester, England, quoted by counsel, he reiterates the remark that the effluent must be dangerous to discharge into Lake Michigan near the intake of the Chicago water supply. This is altogether beside the mark; the case really furnishes convincing proof that the very concentrated sewage of a large city is successfully treated to such extent as to be discharged into a much used navigation canal, not only with no bad results, but actually to improve the quality of water. This is exactly what is needed in the case of the sewage of Chicago which is to be carried off by its drainage canal.

It is recognized in the reports of the experts referred to, and in counsel's arguments, that the dilution method of disposing of the sewage of Chicago is inefficient, inasmuch as it permits the deposition of enormous quantities of putrescent sludge in the Chicago river, along the drainage canal, and in the Desplaines and Illinois rivers; and that screening and sedimentation must be adopted to remedy this serious defect. Also, that the industrial wastes must be specially treated.

Thus, the permit of January 17, 1903, expressly states that the extra water is granted *"in order to carry off the accumulations of sewage deposit which line the shore along the said city."*

This admits the principle that some treatment of the sewage is needed to supplement the defects of dilution and it logically follows that further treatment, as carried out in other cities, would make the effluent fit for discharging, by way of the canal, with little or no dilution.

Counsel objects to purification of Chicago sewage on the ground that a purification plant is less efficient in winter than in summer, and quotes Columbus, Ohio, as a case in point. He says "that the climatic conditions in and around Chicago would be decidedly inimical to the efficient operation of any purification plant"; but all that he adduces in proof is that purification processes are less active in extreme cold weather

than in summer, and quotes the Columbus plant as his example. The learned counsel is quite wrong upon this point. Mr. Wisner, chief engineer of the Sanitary District, in his report on the "Disposal of Chicago Sewage," makes statement in direct contradiction to the contentions of counsel: He says: "From experiments carried on at the Thirty-ninth street testing station it is evident that, with sewage largely domestic and well prepared by settling, a yield of 2½ to 3 million gallons per acre per day may be expected with a bed of stone 1½ to 2 inches in size, and 6 to 7 feet deep, and that the effluent will be stable for the greater portion of the year.

"Covering the filters will make a marked difference under any condition, causing the filter to deliver an effluent higher in nitrates during the winter months, and also nonputrescible. It is doubtful, however, whether it is necessary in the immediate future to cover filters, as satisfactory results can probably be obtained with open filters under weather conditions in Chicago. Even if the effluent is not as stable in the colder weather, the higher content of oxygen in the cold lake water will more than take care of the difference in the stability of the effluent."

Counsel draws attention to the terms used in our brief describing the purification plant at Baltimore, which implies that that plant is in actual operation. We are glad to correct the implication, and to explain that the language does not assert, and was not meant to imply that the works are actually in operation, but simply that the effluent from the sprinkling filters necessarily well purified, will be further treated in order to completely sterilize it.

It may, however, be added that the example loses neither force nor fitness by the correction, for it still shows that Baltimore has deemed it feasible and wise to both purify and sterilize its sewage, for the preservation of the life and health of its inhabitants and to keep wholesome its Chesapeake Bay oysters, and it, therefore, cannot be considered either impracticable or unreasonable to require that Chicago, for the preservation of the life and health of its citizens, shall install partial purification plants at the sacrifice of some of its power production works.

III.

In view of the fact that counsel for the Sanitary District has thought fit to give a brief historical sketch of the conditions at Chicago, prior to the initiation of the Drainage

Canal scheme, a few additions to the sketch may be pertinent:

In 1882, the United States granted a right of way through the public lands and, in 1827, made a grant of land to the State of Illinois to aid "in opening a canal to connect the waters of the Illinois river with those of Lake Michigan." Work was commenced in 1836 and, in 1848, the canal was opened from the Chicago river at Bridgeport to the Illinois river at La Salle. The summit level was eight feet above Lake Michigan (low water of 1847, Chicago datum), and, in time of drought—about 45 days in the year—received water by pumping from the Chicago river at Bridgeport.

In the late "fifties" the City of Chicago entered into an agreement with the canal authorities whereby the latter agreed to pump water all the year round, thus improving the sanitary condition of the Chicago river.

Later, a further agreement was made whereby the City of Chicago cut down the summit level. This work was completed in 1871, and 150 cubic feet per second was diverted from the Chicago river to the Desplaines river. The difference between the summit level of the canal and Lake Michigan, however, was so small that certain winds lowering the lake level, or a very heavy rainfall, would set the current in the Chicago river east into the lake.

The original land surveys show that in times of high water, the Desplaines river overflowed the low water parting and discharged into the south branch of the Chicago river. The Internal Improvement Commission of Illinois, Isham Randolph, Chairman, state in their report, 1909, that "The inference is plain, that the south branch of the Chicago river with its two forks, was the proper outlet for the flood waters of the Desplaines river and was maintained thereby. * * * What occasioned the diversion down the present course of the Desplaines river is a matter of speculation—it may have been due to silt deposits initiated by a beaver dam. * * * The present course bears every evidence of being very recent. * * * In 1849, the divide was overflowed at the spring breakup (much as in 1675, when Marquette was driven from his cabin) with ice gorges and great destruction of shipping and bridges in the Chicago river."

Even in 1877, after the new dam in the Ogden-Wentworth canal was constructed, at times of high floods, 75 per cent. of the Desplaines river waters came through Chicago as they did before the dams were built. As a result, the old pumping works at Bridgeport were rebuilt.

In brief, from the opening of the canal in 1848, to 1871, an insignificant amount of water was *pumped* from the Chicago river to the Desplaines river; from 1871, till the Bridgeport pumping station was completed, the canal diverted only 150 cubic feet per second, and, thereafter, till the present drainage canal was opened in 1900, 1,000 cubic feet per second.

Counsel for Chicago argues that the "present canal is a growth and development of the policy of both the State and Nation," and that "it is strange that after a policy has been declared and carried out for a period of ninety years, there should be, at this late date, so strenuous an effort to prevent the protection of the lives of the people of that large community because of some supposed and imaginary injury to navigation upon the Great Lakes."

To argue that the operation of a small pumping plant for 45 days in the year raising an insignificant amount of water for navigation purposes for locks 110 feet long, 18 feet wide and 6 feet deep, justifies the diversion of 10,000 cubic feet of water per second is a somewhat unusual expansion of terminology.

Counsel for the Sanitary District is imbued with the idea that the people tributary to that district are the public, and, that Canada and the opponents of the scheme are fighting for private interests. The waterways serve the public, afford them cheap rates both directly and by competing with railways; they afford the millions along their shores good drinking water, and, like Chicago, a means of diluting their sewage, not however, by throwing the water away, but by leaving it in the drainage basin.

There should be a distinction between the public of a municipality and the whole country. If, by dredging, or placing obstructions in the outlets of the lakes, the levels have been changed, the work was undertaken by the Government representing the whole people, for the benefit of navigation and the country generally. The Government is the one authority that may do as it pleases; the people of Chicago are only a portion of the whole and may do only what the whole permits.

All works carried out by the Federal Government have been for the benefit of the general public rather than for any locality or private interest, by making it possible to build larger and more economical freight carriers, always with a view of attaining cheaper transportation of food and other

supplies necessary for the comfort and welfare of both nations.

Counsel says, "We deal, however, not with future conditions which are uncertain and indefinite, but with actual conditions which exist now; and so long as they do exist, the necessity is imperative that Lake Michigan, the great storage basin provided by nature for the comfort and convenience of man, shall be used to promote the health and comfort of those who may avail themselves thereof."

If all lake cities could, and did, use the lakes as Chicago does, the unparalleled system of inland waterways would be utterly ruined.

The learned counsel for the Sanitary District renews his argument "that transportation companies must accommodate themselves to the natural conditions regarding fluctuations in lake levels," and contends that this argument in that respect is not fallacious. But no one makes any objection to the argument as stated in the above quotation. The objection applies to the fallacious contention that, navigation interests can afford to ignore any artificial aggravation of the troubles arising from natural conditions, and it is sheer folly to submit to the serious consideration of any tribunal a suggestion that, because, in the course of business, one loses any valuable commodity in a considerable variety of ways, he will not be prejudiced by any additional loss.

Since the culmination of a "high" cycle in the "eighties," the level of the Great Lakes has fallen below the average level that obtained prior to that period, and a critical examination of the gauge readings demonstrates that we have entered upon an era of distinctly lower levels. It is not possible to allocate to deficient precipitation, development operations and causes other than the Sanitary Canal, the proportion due to each. But, in the case of the Sanitary Canal, no such difficulty exists. The amount abstracted, instead of being inappreciable on account of the extent and variety of other losses, comes, in fact, as a very serious aggravation of the trouble.

The accompanying profile shows, diagrammatically, the actual effect upon the gauge heights of Lakes Michigan, Huron, Erie and Ontario, assuming that the full effect of the diversion of 7,000 cubic feet per second has been experienced during the years 1909, 1910 and 1911. The *bottom* of the solid black indicates actual gauge readings during these years, while the top indicates what the gauge readings would have

been but for the 7,000 c.f.s, diversion. If 10,000 cubic feet per second had been diverted, the gauge heights would have been reduced to the bottom of the red band.

It is necessary, however, to point out the complete inaccuracy of the statement submitted by counsel as the foundation for his examination of the calculations of the losses suffered by transportation companies. He states that "The only vessels now sailing the Great Lakes which could be affected by any variation in lake levels of from 3 to 5 inches are owned and operated by the ore-carrying companies, particularly the Pittsburg Steamship Co., which is a subsidiary company of the United States Steel Corporation."

This statement is simply not true, and doubt is thrown upon the accuracy of the information in the possession of the Sanitary District with reference to lake navigation.

The truth is that every vessel mentioned in connection with the statements submitted on behalf of the Dominion Marine Association and the Shipping Federation of Canada, is, at least in periods of low water, seriously affected by "variations in lake levels of from 3 to 5 inches." If they are loaded at the head of the lakes for Georgian Bay ports or Goderich, Point Edward, Port Colborne or Buffalo, they feel even such a slight variation at once, for the permitted draught of water at the Canadian canal at Sault Ste. Marie, at the opening of navigation, in the coming season is to be only 17 feet 5 inches for upbound vessels and 17 feet 10 inches for those downbound. If they are loaded for Kingston or Montreal, they feel the loss of even an inch of water at the Welland canal, or if not, then at the Rapide Plat in the St. Lawrence river or at some one of the various St. Lawrence canals. The same statement applies, not in theory, but infact, to every vessel that finds occasion to enter a harbour of limited depth anywhere on the lakes or river. Ocean tonnage, again, feels the loss in the same way, and reference must be had to the statements submitted on behalf of the two Canadian Associations mentioned as well as what was said by counsel for these bodies at the hearing in Washington on the 27th March last. These statements, it is submitted, are not at all met by any such methods as those adopted in the brief submitted for the Sanitary District.

The brief in question proceeds to state "that the profits of transportation companies depend, not upon the depth of water but upon the amount of freight carried," and "that it is not and cannot be truthfully contended that any freight

has not been carried by reason of lack of water which would otherwise have been." In answer, it is submitted that the remarks above quoted are so far removed from being statements of fact that they scarcely require contradiction. To take only one concrete case, the Canadian steamer "E. B. Osler" which could carry, three or four years ago, something over 10,000 tons of coal per trip, could, and did, in 1911, carry only something over 8,000, thus losing *not in imagination or theory, but in fact,* about 2,000 tons per trip with corresponding loss in earnings. It is an uncontroverted fact that vessels were forced to go down the Welland canal last year under restrictions as to draught, and were even turned back by canal officials to unload cargo at Port Colborne when drawing an inch or two too much. It is also an uncontroverted fact that boats ran the St. Lawrence at 12 feet and some inches draught which should have carried, and desired to carry, 14 feet, and that they were required on occasions, to go back and take out cargo at Prescott before being permitted to proceed. It is an uncontradicted fact that loss and inconvenience were suffered by ocean tonnage in the river below Montreal, and, in the face of these facts, the statements and arguments in the brief for the Sanitary District are futile and worse than useless.

It is also useless to contend that, in periods of high water, the loss due to the action of the Sanitary District may not be felt, for that is not the question immediately at issue, and it is utterly absurd to contend that no one has yet made the slightest claim up to this date, that navigation has been impaired by the operation of the Sanitary District canal; for we are dealing with existing conditions and every complaint that has been made, has applied to every inch of loss already suffered, and, it may be added, that all engineers agree, that, in periods of low water, the loss in level for a given withdrawal of water is very much greater than at times when the water is high.

In the brief submitted by counsel for the Sanitary District, attention is drawn to a supposed discrepancy in the figures used to show the loss of depth at the Rapide Plat by the International Waterways Commission, and those submitted by the representatives of Canada. The figures submitted for the Dominion of Canada were computed for periods of *low water* whereas those quoted from the report of the International Waterways Commission were calculated for *mean water,* a fact apparently ignored, or overlooked, in counsel's brief where comment is made on the difference between these

figures and other expert estimates. The figures submittd for the effect of the diversion at Montreal have been obtained from the best information now in possession of the Government Departments. This information has been acquired by direct flow measurements made since the publication of the report of the International Waterways Commission mentioned.

Counsel quotes "from chart No. 2483 of the Canadian Government charts of the Harbour of Montreal." This chart has not been published by the Canadian Government, and the figures cited by counsel do not correctly show the depths which govern the navigable draught in Montreal harbour. The latest chart of this harbour shows 30 feet in the channel approaching the piers and 29 feet alongside the wharves. It was dredged to what was considered a safe depth for a certain draught. If it be reduced by six or twelve inches, there can be no question that the efficiency of the harbour is greatly impaired.

Counsel states that:

"According to the Forty-third Annual Report of the Department of Marine and Fisheries of Canada of 1910 the total expenditure on the improvement of the St. Lawrence river, since 1851, by all public appropriations, has been $11,400,000. This is practically the amount that has been expended by the Sanitary District alone in the improvement of the harbour facilities in the Chicago river.

"Navigation interests represented by a government that has expended in their behalf less than one-sixth of the money expended by the Sanitary District for health and sanitation should not expect their protests to be seriously considered."

Counsel is under a misapprehension in this regard, as the amount referred to applies only to the improvement of the St. Lawrence Ship channel below Montreal prior to 1910, whereas the expenditure incurred by the Canadian Government, up to the end of the fiscal year 1910-11, on the St. Lawrence above Montreal in canal works, dredging of channels, harbours, &c., amounts to $52,000,000. To this amount must be added $20,000,000 expended on Montreal Harbour works, and $13,436,000 on the River St. Lawrence Ship channel below Montreal.

This makes a total expenditure of $85,436,000 incurred by the Canadian Government for the improvement of navigation on the St. Lawrence river between Lake Ontario and Quebec.

In addition to the above amount, $36,881,000 have been

expended on the Welland canal, $5,631,000 on the Sault Ste. Marie canal, and $21,000,000 on dredging and harbour works on the Great Lakes, making a grand total of $149,000,000 expended on works that are adversely affected by the diversion at Chicago.

As the improved St. Lawrence river and canals are entirely free to shipping interests on both sides of the boundary, most of this expenditure has been of benefit to both countries. Splendid results have been obtained by these improvements to the comfort and welfare of the citizens of both countries, but, on a system of navigation like the St. Lawrence, every inch of water in depth counts, and must be saved. Is this system which is utilized by both nations now to be impaired by the tapping of its source of supply, and by allowing part of this supply to be diverted to another valley to further the schemes of a city which should use some other means of disposing of its sewage?

Compensating works: Counsel submits a letter from Mr. Alfred Noble, of New York, on the subject of compensating works, but this contains no positive statement that they can be so constructed as to be effective. Such works should only be a possible remedy to be applied in extreme and absolutely unavoidable cases. Their enormous cost, *which must be borne by the Sanitary District*, the international difficulties involved, the numerous important interests that would be adversely affected, and other similar conditions, demonstrate the practical impossibility of ever constructing such works for conserving the levels of the Great Lakes. In addition, as stated in the report on Regulation of Lake Erie by the International Waterways Commission, works that would regulate the levels, at or near, some fixed stage would be so detrimental to the lakes and rivers below as to be inadmissible.

Replying to counsel's statement that:

"It may be here observed that a protest from the Dominion of Canada against the lowering of lake levels comes with rather poor grace. It is a matter of record, in your Department that during the improvement of the Detroit river in the construction of the Livingstone channel, the United States Government sought to maintain the level of the lakes by the construction of remedial works on the Canadian side. A protest was entered on behalf of the Canadian Government, and these remedial works have not been constructed as was planned by the United States engineers."

This statement ignores the fact that the Government of

Canada, in an Order in Council dated 11th January, 1911, recommended that, in view of the very strong protests, made by municipalities on the Canadian shore, further investigations should be made regarding the matter. It was further suggested that probably the whole subject would be better dealt with by the International Joint Commission.

Reference is made to the fact that "from May, 1911, when Lake Superior was at its lowest stage for the year, it had risen so that on January 1st of this year it was practically one foot and three-tenths higher than in May, 1911, During the same period Lake Michigan has only risen about two tenths of a foot." It is argued by the learned counsel that this is due to the obstructions in connection with the construction of the new Soo locks, and that, but for this interference with the flow, Lakes Michigan and Huron would have been in the neighborhood of three inches higher at the present time than they are. In reply, it may be stated that this obstruction was placed in the St. Mary river about two years ago, but its effect on the lower lakes could be only temporary. By the present time, the natural outflow from Lake Superior has been re-established and levels in Lakes Huron-Michigan restored.

Counsel for Chicago states that nearly 11½ million dollars have been expended in improving the Chicago river and urges that "this is an ample guarantee that the Sanitary District is safeguarding the commercial interests of the port of Chicago, and is doing all in its power to see to it that navigation will not be interfered with nor the interests of her Canadian friends injuriously affected."

The learned counsel centres attention only upon the port of Chicago. While it has been improved, it is wholly outside the mark to argue that "the grand total of the sums of money" expended by the Sanitary District at the port of Chicago is a proof that Chicago's "Canadian friends" are not being "injuriously affected." The statements already made before the Secretary of War, on behalf of the Government of Canada, and the Dominion Marine Association, and other Canadian interests, show that the diversions by the Sanitary District of Chicago do cause, throughout the whole extent of the St. Lawrence system, serious injuries to navigation, and other Canadian commercial enterprizes.

CONCLUSIONS.

We respectfully submit that it has been abundantly shown:

(1) That there is no imperative necessity for such a large diversion of water from Lake Michigan for sanitary purposes, as is requested in the application.

(2) That the historical facts presented in this brief show conclusively that the Sanitary canal cannot be considered as the outgrowth and development of a scheme which has received recognition by the United States Government, or that of the Dominion of Canada.

(3) That the claim that the Sanitary District is entitled, as a matter of right, to the use of so much of the waters of Lake Michigan as may be necessary for sanitary and domestic purposes, cannot be entertained in so far as it relates to the extraordinary and wasteful use proposed.

(4) It has been shown that very substantial injuries have been made, and are being suffered by navigation interests. Fears for future and more extensive damages, by reason of increased diversion, are exceedingly well founded, and justify the demand that some improved method of sewage disposal, which shall not require the abstraction of any considerable quantity of water from Lake Michigan nor the diversion of other outlets of waters which would naturally flow into it, be adopted.

(5) That the Dominion of Canada has the right to a voice in the disposition of the waters of Lake Michigan for sanitary purposes in so far as such diversion injuriously affects navigation, because her citizens are accorded, by treaty, the right of free navigation in that lake, and, in that no diversion can be made without injuriously affecting her harbours, channels and canals.

(6) It having been shown that the sewage of Chicago can be so treated and disposed of by other means than the present dilution methods, by which great quantities of water are withdrawn from Lake Michigan and discharged through the Drainage canal into the Illinois river, it is contended, on behalf of Canada, that the abstraction of water from Lake Michigan shall be limited to such quantity as shall not injuriously affect navigation interests on the Canadian side of the boundary, and that such limitations shall take effect at the end of such time, as, in your judgment, may be reasonably necessary for the Sanitary District to instal, and put into use, the works which may be required for disposing of

the sewage by other means than by the dilution method now in use.

(7) That, in view of the fact that the Sanitary District claims that permits hitherto issued deal only with the flow through the lower portion of the Chicago river, and that it has the right to take any amount of water, without permission, through the canal, provided it is supplied through other feeders, it is respectfully requested that all permits be only for such limited quantity of water as shall not injuriously affect navigation on the lakes and the St. Lawrence river, and be so worded as to state the total quantity which the Sanitary District of Chicago may be permitted to withdraw for domestic and sanitary purposes from the drainage basin of Lake Michigan.

We feel confident that the interests of humanity at Chicago, and the levels of the Great Lakes, and of the St. Lawrence river, can best be protected by the installation of a modern system of sewage disposal, rather than by using a method which has been shown to be injurious to the navigation and commerce of both nations, and, further, that the interests of the public generally will thus be protected and their welfare promoted.

Respectfully submitted,

Daniel Mullin, K. C.,
Counsel,
John Kennedy,
Consulting Engineer.
A. St. Laurent,
Assistant Deputy Minister Public Works, Canada,
Wm. J. Stewart,
Chief Hydrographer,
V. W. Forneret,
Superintending Engineer St. Lawrence Ship Channel,
Representing the Government of Canada.

Chicago, Ill., March 11, 1912.

Memorandum of opinion of Lieutenant Colonel George A. Zinn, then engineer in charge at Chicago, to the Secretary of War.

The Secretary of War is asked to grant a permit for the withdrawal of 10,000 cubic feet of water from Lake Michigan through the Main Sanitary Canal which terminates near Lockport, Illinois, and discharges into the Desplaines river at that place, from the Desplaines river thence into the Illinois river.

Has the Secretary of War jurisdiction in this matter and has he authority to issue such a permit? If it is determined

that the Secretary of War has jurisdiction and the necessary authority, the issuance of this permit will then depend upon the relative advantages and disadvantages, benefits and injuries which will follow the granting or withholding of it.

The jurisdiction of the Secretary of War over the navigable waters of the United States is derived from special and general legislation. The general legislation is found in the river and harbor act approved March 3, 1899, which defines the duties of the Secretary of War and determines the extent of his jurisdiction. It may be inferred that the jurisdiction of the Secretary of War is limited to the items named in that act. Under that act he may order the removal of bridges obstructing navigation, remove wrecks interfering with navigation, establish harbor lines when essential to the preservation and protection of harbors, authorize the creation of obstructions and the alteration of navigable channels in the navigable waters of the United States. Under the river and harbor act of August 18, 1894, it is the duty of the Secretary of War to prescribe rules and regulations for the use, administration and navigation of any or all canals and similar works of navigation that now are or may hereafter be owned and operated by the United States. He is also authorized to prescribe regulations covering the speed and movement of vessels and the opening of draw bridges. The acts of May 9, 1900, and March 3, 1905, further increase the jurisdiction of the Secretary of War over navigable waters. Section 10 of the Act of March 3, 1899, may perhaps be interpreted to confer upon the Secretary of War the necessary authority to grant the application of the Sanitary District, although if it be shown that the granting of the application will create an obstruction "not affirmatively authorized by Congress" the secretary has no authority in the case.

It would appear that the War Department entertained a doubt as to its authority from the language used in the two permits issued under date of July 11, 1900 (E. D. 35041/17 and 18), granting permission to the Sanitary District of Chicago to change, alter and improve the Chicago river. Condition 1 of both of these permits states:

That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the Sanitary District of Chicago to Congress for consideration and final action and that this permit shall be subject to such action as may be taken by Congress.

Let it be assumed that the Secretary of War has both au-

thority and jurisdiction, his action in this matter, as previously stated, will be determined by weighing the relative benefits and injuries, advantages and disadvantages attached to granting and withholding the permit.

Consider first the case of withholding the permit. The City of Chicago now empties all of its sewage and refuse matter flowing from streets, both solid and liquid, into the Chicago river. There are no catch basins at the river ends of the sewers and the street catch basins are inefficient so that large quantities of solid matter necessarily flow into the Chicago river in violation of Section 13 of the river and harbor act of March 3, 1899. It is reported that city officials have said that it would be cheaper to dredge the river than to build catch basins. That large quantities of solid matter do go into the river from city sewers and from overflow from streets is shown in the report of Mr. G. M. Wisner dated October 12, 1911, to the Board of Trustees of the Sanitary District of Chicago, in which Mr. Wisner states that the Main Sanitary Canal has been filled to the extent of about 2,340,000 cubic yards which fill must be removed to restore the main channel to its proper capacity. Some shoaling is known to have taken place in the Chicago river after the river was dredged by the United States and the Sanitary District.

The present allowance (permit of December 5, 1901), of 250,000 cubic feet per minute (4,167 cu. ft. per second) is not sufficient to properly dilute and carry off the sewage of the present population of the Sanitary District of Chicago, which includes the City of Chicago and some outlying territory. With the constantly increasing population of the Chicago region, it is evident that there will be a constantly repeated demand for more water for dilution. Many large cities at home and abroad have found themselves obliged to abandon the dilution method. It is not only possible for the Sanitary District to dispose of its sewage without an increase in its present allowance, but also imperative for it to adopt another system; if not now then in the near future. Other systems are available which will not require an increase in the present allowance.

Again, the adoption of some other system will not result in or require the abandonment of the existing channels and works of the Sanitary District.

Under present conditions, the Sanitary District cannot make use of the 10,000 cubic feet per second without creating a current in the Chicago river which will be injurious to navi-

gation. The 10,000 cubic feet required can only be used without injury to navigation after the Sag canal and other works contemplated for the removal of sewage in the Calumet region, recently placed under construction, have been completed, which event is not expected to take place within several years. The Sanitary District officials admit that they are now withdrawing about 7,000 cubic feet per second from Lake Michigan; the excess above 4,167 ft. per second being in violation of the terms of their permit. The current now existing in the river is injurious to navigation, as shown by collisions between vessels and bridges and the difficulty of stemming the current. The withdrawal of water from Lake Michigan has undoubtedly resulted in a permanent lowering of the water surfaces of all the Great Lakes.

At present the War Department has no practical means for determining the amount of water drawn from Lake Michigan. Effective supervision over the operations of the Sanitary District will be difficult and expensive.

The practical effect therefore of withholding an increased allowance will be to force the Sanitary District of Chicago and the City of Chicago to adopt another system of sewage disposal, or a combination of the present system with another system.

Consider now the effect of granting the application of the Sanitary District.

As justified, the increased allowance cannot be used immediately without injury to navigation in the Chicago river, and the temptation to use it will be very great, as the Sanitary District has up to now succeeded in escaping punishment for its offenses against the United States and navigation interests.

When the Sag canal is completed and the 10,000 cubic feet per second may be withdrawn without producing injurious currents in the Calumet and Chicago rivers, the other effect, previously referred to, of lowering the lake surfaces of the Great Lakes will be greatly increased, resulting in lessor depths in all lake channels and harbors, greatly diminished carrying capacity in vessels, etc.,—an injury which, measured in dollars and cents, will equal in a very few years the total cost of a new sewage system for the City of Chicago.

Has the Secretary of War authority to permit such injury even should he so desire?

There seems to be no question of the right of the United States to divert water flowing in navigable streams from one

place in the stream to another place in the same stream for the benefit of navigation. See case of *South Carolina* v. *Georgia et al.* (3 Otto, 4). The right of an individual, a state, or the United States to divert water from navigable streams or bodies to non-navigable streams has not been adjudicated to my knowledge.

It may be asserted that the diversion of water in the present case is from one navigable body of water (Lake Michigan) to another (Illinois river). The diversion, while beneficial, is not necessary for the improvement of navigation on the Illinois river or Lake Michigan. The right of the State of Illinois to use water from Lake Michigan for purposes of navigation in its Illinois and Michigan canal, connecting Lake Michigan and the Illinois river, has not been questioned, but the quantity used is practically nothing. Whether the diversion of water for navigation purposes in the Illinois and Michigan waterway in sufficiently large quantities to injure navigation on the Great Lakes would be legal or proper remains to be determined.

The granting of the permit applied for by the Sanitary District would result in an immediate and vast injury to navigation on the Great Lakes and would be of only temporary benefit to the Sanitary District of Chicago. Moreover, it appears to be a question that can properly be determined only by the Congress of the United States.

It is reported that 650,000,000 gallons of water per day are pumped from Lake Michigan by the various water works of the City of Chicago into its water supply system. A very small quantity of this amount of water returns directly to the lake the rest being discharged from streams and sewers into the Chicago river. This quantity is equal to 1,005 cubic feet per second and it is presumed that this withdrawal of water is included in the quantity allowed to be withdrawn by the Sanitary District of Chicago.

Attention is invited to Article III, *Treaty between the United States and Great Britain,*—boundary waters between the United States and Canada, Proclaimed May 13, 1910, which reads as follows:

It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary-waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of

the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a joint commission, to be known as the International Joint Commission.

The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the improvement of harbors, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

(Sgd.) GEO. A. ZINN,
Lieut. Col., Corps of Engineers.

EXTRACTS FROM PROTESTS OF VARIOUS CITIES, ASSOCIATIONS, PROPERTY OWNERS AND INDIVIDUALS ON THE SHORES OF THE GREAT LAKES AND ALONG THE ILLINOIS RIVER.

Protest of Duluth Commercial Club, February 24, 1912.

"The Chief of Engineers. In reference to the desired increase for more water from the Great Lakes to pass through the Drainage canal at Chicago, we desire to enter our protest against any increase of the amount now allowed. We are of the opinion that for the conveyance of sewage both for the present and for the future, the water is now sufficient if the channels in the low lands and wide parts of the river are constructed in proportion to the canal. There is owned at this port several freighters of the largest class of freighting ships in the world. They combine and carry in one cargo more than one and one-half million tons from Lake Superior to the lower lakes. The depth of the connecting rivers are affected by the level of Lakes Huron and Michigan. These we think are now lowered by the present amount of water passing through the Drainage canal and think there is some evidence to support this in the last two years. The lowering of these rivers seriously affects the carrying capacity of these large steamers and we earnestly protest against granting any increase.

DULUTH COMMERCIAL CLUB."

Telegram From Mayor of Duluth to Secretary of War, Feb. 27, 1912.

"The common council of the City of Duluth has this day adopted a resolution in opposition to the granting of permission to the City of Chicago to withdraw from Lake Michigan 10,000 cubic feet of water per second on the grounds that such a diversion of water would be a menace to navigation on the Great Lakes.

N. B. Cullum,
Mayor."

Resolution of The Greater Milwaukee Association to the Secretary of War, Feb. 27, 1912.

"Resolved by the Greater Milwaukee Association by its Board of Directors and Advisory Board in meeting assembled on February 27, 1912, that the request of the Chicago Drainage Canal authorities made to the Secretary of War of the United States of America for a further diversion of lake waters should be refused because such proposed diversion would be inimicable to the best interests of the public; and it is furthermore

Resolved that the Secretary of this Association shall forthwith dispatch to the Secretary of War of the United States of America a telegram as follows:

'The Greater Milwaukee Association by its Board of Directors and Advisory Board in meeting assembled on February 27, 1912, does hereby request the Secretary of War of the United States of America to refuse consent to the Chicago Drainage Canal authorities for a further diversion of lake waters for the reason that such a proposed diversion will seriously affect the lake levels by lowering the several harbor entrances and river levels in the ports of Lake Michigan. The Greater Milwaukee Association believes that the waters of the Great Lakes should be utilized for purposes of navigation and for sanitation only so far as conditions will permit. That the proposed increased diversion of these waters for the purposes of the Chicago Drainage Canal authorities would be inimicable to the best interests of the public.' "

Telegram From Herman Bleyer, Secretary Harbor Commission, to Secretary of War, February 27, 1912.

"Milwaukee Harbor Commission is now engaged in the task of devising means of improving present harbor conditions and formulating plans for the city harbor needs in years to come, [and] regards with solicitude the apparent increasing natural tendency toward lower water levels in the Great Lakes which if continued must result in added expense for river and harbor maintenance and great depreciation in carrying capacity of lake tonnage. In view of this disturbing aspect the Commission is unalterably opposed to anything which will in any manner lend its influence toward lower water levels on the lake. The Commission therefore respectfully but firmly protests in behalf of the shipping interests of Milwaukee against the further diversion of waters of the Great Lakes for any purpose whatsoever and earnestly appeals to the federal authorities to refuse all applications for water privileges now under consideration or which may be made in the future."

Resolutions of Merchants and Manufacturers Association of Milwaukee, March 5, 1912.

"Whereas the diversion of the waters of Lake Michigan in recent years for navigation, sanitation and power purposes, together with a reduced precipitation has tended toward the lowering of the lake level to a point where the efficiency of the several harbor entrances and river beds is seriously threatened, thus indicating that any further and permanent diversion of such water will tend to aggravate an already serious situation, be it

Resolved, that we, the Board of Directors of the Merchants and Manufacturers Association, believe that the primary and guaranteed purpose of the Great Lakes is dedicated to the use of navigation and therefore the duty of the government to maintain and protect the water levels in the interest of such navigation; that the use of the lake waters in large volumes for power purposes to the detriment of navigation is untenable, unwarranted and unjust and therefore should not be permitted; and be it further

Resolved, that we herewith enter our solemn protest against the demands of the City of Chicago and State of Illinois for any diversion of the waters of Lake Michigan which may by any possibility affect the level of the lake as existed under natural conditions."

Telegram From Francis E. McGovern, Governor of Wisconsin, to Secretary of War, Feb. 26, 1912.

"In the interest of the Wisconsin Lake ports I respectfully but earnestly protest against any increased diversion of water from Lake Michigan by Chicago Drainage Canal.

FRANCIS E. MCGOVERN,
Governor."

Telegram From Mayor of Two Rivers, Wisconsin, to Chief of Engineers, February 26, 1912.

"Being impossible to have a representative at hearing on February 28th, the City of Two Rivers, Wisconsin, hereby enters vigorous protest against granting of application of Sanitary District of Chicago to divert increased flow of water from Lake Michigan through Drainage canal, knowing it would be detrimental to the shipping interests of the Great Lakes and damaging to the improvements made by the government and municipalities as well as corporations and private individuals, by lowering this state of water.

CONRAD BAETZ,
Mayor."

Telegram From Mayor of Manitowoc, Wisconsin, to Secretary of War, Feb. 26, 1912.

"Mayor and city council of Manitowoc, Wisconsin, resolve to address the Secretary of War, following:

'The city protests against granting the pending application of the Sanitary District of Chicago for permission further to divert water from Lake Michigan through the Drainage canal in quantity proposed or any quantity. We believe permanent diversion will cause great and irreparable injury to this city.

'Every inch of the present depth in Manitowoc river is of great value to this city and to thousands of shippers and consumers both east and west of this port. If this proposed diversion will lower lake levels, which we deem unquestionable, it will work gross injustice to this and other upper lake ports that have been solving low water problems under work on river channels done at great expense to taxpayers. It will make sheer waste of large part of millions spent by federal government on harbors. Water works are city property and supply is from wells sunk in shore on Lake Michigan, largely

if not entirely supplied by percolation from lake, the surface levels of which rise and recede with surface of Lake Michigan. Present low lake level has so impaired supply that further material recession of lake level will utterly destroy water supply, necessitate entire rebuilding of pumping plant and result in great financial burden to city and county.'

HENRY STOLZE, JR.,
Mayor."

Telegram From Kewaunee, Wisconsin, to Congressman T. F. Konop, February 26, 1912.

"Council adopted resolution protest against further diversion water through Chicago Drainage Canal. Requested to appear behalf city. Letter follows.

W. WIESNER."

Resolution of Protest of Mayor and Common Council of City of Marinette, Wisconsin, February 24, 1912.

"Whereas, the Sanitary District of Chicago has made application to be allowed to divert ten thousand cubic feet of water per second from Lake Michigan through the Drainage canal, and

Whereas, such a flow of water would tend to perceptibly lower the level of Lake Michigan, thus making our harbor inadequate for deep draft vessels,

Now, Therefore, Be It Resolved, by the Mayor and Common Council of the City of Marinette

That we do earnestly protest against allowing any further diversion of water through the Chicago Drainage Canal and we do hereby petition the Honorable, the Secretary of War, and ask that he refuse to allow any further diversion of water from Lake Michigan through said canal.

Passed, adopted and approved this 24th day of February, 1912.

JOSEPH FISHER,
Mayor of Marinette.

Attest,

JOHN MOORE,
City Clerk."

Telegram From Marinette Chamber of Commerce to Senator Isaac Stephenson, of Wisconsin, February 26, 1912.

"* * * The Marinette Chamber of Commerce hereby most earnestly protest against the maintenance of any artificial outlet and hereby urge the Board of Engineers of the War Department to deny the application of the Chicago Drainage Canal Board for the diversion of an additional flow of Lake Michigan water through the Chicago Drainage Canal.

MARINETTE CHAMBER OF COMMERCE,
HORACE C. BAKER,
Secretary."

Resolution of Protest of Mayor and Common Council of Sheboygan, Wisconsin, February 23, 1912.

"* * * Whereas the government and cities have spent millions of dollars in giving the cities along the Great Lakes sufficient water to permit the use of the present lake freighters, and the past few years have demonstrated that the lake level was getting to a point where it is difficult to keep the harbor dredged to the required depth, therefore be it

Resolved by the Mayor and Common Council of the City of Sheboygan that we do protest strenuously against the granting of the application of the Sanitary District of Chicago, believing that the same is wholly unnecessary for the direct purposes mentioned, and even assuming it is for the purpose mentioned and none other, nevertheless we do protest for the reason above stated. * * *"

Resolution of Protest by Mayor and Common Council of City of De Pere, Wisconsin, February 24, 1912.

"Whereas the level of water in Lake Michigan has lowered to an alarming extent during the past two years, which is claimed by eminent authority to be caused by the amount of water now permitted to be taken by the Chicago Drainage Canal, and

Whereas, the lowering of the level of the water in Lake Michigan endangers the safe navigation of large freight carrying boats on Lake Michigan and Green Bay and the smaller boats on Fox river below, and

Whereas should the level of the water continue to lower it will practically destroy all of the water shipping facilities and

work gross injustice to our shippers as well as to the general public, and

Whereas this community and that adjacent thereto depend to a large extent upon the lake shipping facilities for the carriage of coal, merchandise and other commodities,

Now, Therefore, Be It Resolved by the Mayor and Common Council of the City of De Pere, Wisconsin, that for and in behalf of the people of this city, we do hereby object to and protest against granting permission for taking of any larger volume of water for said drainage canal than at present permitted until such time as it shall be established beyond doubt that the taking of water for such canal does not tend to lower the level of the water in Lake Michigan. * * *"

Protest of Mayor and City Council of Green Bay, Wisconsin, Feb. 23, 1912.

"Whereas the Sanitary District at Chicago has made application to be allowed to divert ten thousand cubic feet of water per second from Lake Michigan through the drainage canal, and

Whereas, such a flow of water would tend to perceptibly lower the level of Lake Michigan, thus making our harbor inadequate for draft vessels;

Now, Therefore, be it Resolved by the Mayor and Common Council of the City of Green Bay,

That we do earnestly protest against allowing any further diversion of water through the Chicago Drainage Canal and we do hereby petition the Honorable, the Secretary of War and ask that he refuse to allow any further diversion of water from Lake Michigan through said canal.

John S. Farrell."

"The above resolution was adopted by the unanimous vote of the Common Council at a meeting held February 23, 1912."

Signed by City Clerk.

Telegram From Secretary Michigan State Senate to Secretary of War, February 28, 1912.

"Dear Sir: At the session of the Michigan State Senate today the following resolution was adopted and I was directed to transmit the same to you forthwith:

Whereas application has been made to the Secretary of War for the diversion of ten thousand cubic feet of water per second into the Chicago canal, and

Whereas this will practically double the flow of water from Lake Michigan into the canal and not only endanger our harbor but be a great menace to our fruit industry which, though it has reached such proportions, is as yet only in its infancy, and

Whereas a hearing on said application has been fixed by the Secretary of War to be heard before him in his office in the War Department at Washington on Wednesday, February 28,

Therefore Be It Resolved this, the Senate of the State of Michigan, that on behalf of the popele of this state, we desire to enter a vigorous protest against the granting of such application for the Sanitary District of Chicago."

Telegram From Clerk of the House of Representatives, State of Michigan, to Secretary of War, February 28, 1912.

"The Michigan House of Representatives has this day unnimously adopted a resolution vigorously protesting against the granting by your Department of the application for diversion of ten thousand cubic feet of water per second from Lake Michigan on the ground that such action will practically double the flow of water. Every port in Michigan will be injured; every fruit farm in Western Michigan jeopardized, and the future development of the state hindered and perhaps permanently stopped. I am directed to wire this protest to you."

Letter of J. C. McLoughlin, Member of Congress, to Secretary of War, February 28, 1912.

"On behalf of the people of Western Michigan I wish hereby to object to the application of the Sanitary District of Chicago for authority to divert ten thousand cubic inches (feet) per second of water from Lake Michigan. The Congressional District I represent is in Western Michigan, has a coast line on the lake of about one hundred and fifty miles, and has eight harbors which were constructed and are maintained by the federal government. The said Sanitary District has authority to divert about four thousand cubic per second from Lake Michigan but for several years, as I am informed, diverted and is now diverting about seven thousand cubic feet, the result and effect of which diversion is that the level of the water in said lake has been so lowered as to make navigation of said harbors difficult and dangerous and their maintenance very expensive.

There are local reasons and conditions which influence the people of Michigan to resist the application made by the Sanitary District. The City of Muskegon takes its entire supply of water for domestic use and for fire protection from Lake Michigan. A pumping station has been built in the shore of lake. Intake pipes, cribs and wells have been laid and constructed. The low situation of water prevailing during recent years on account of diversion of water by said Sanitary District has made the maintenance and operation of said water plant very difficult and expensive. Said plant was constructed before water was diverted from Lake Michigan by said Sanitary District or by any other authority for such purpose as it is now diverted and used. If the level of Lake Michigan be further reduced by the diversion of the quantity of water demanded by the Sanitary District it will be necessary for the City of Muskegon to change and rebuild its entire water plant, which would involve an outlay of many thousands of dollars. * * *"

Telegram Mayor and Secretary of Chamber of Commerce, Charlevoix, Michigan, to Secretary of War, February 26, 1912.

"On behalf Charlevoix County's entire population protest against further concessions Chicago Drainage Canal. Water level already seriously affected and immense fruit interests jeopardized through chemical changes due to diversion of natural water flow."

Telegram From Mayor and City Council of Escanaba, Michigan, to Secretary of War, February 27, 1912.

"The City of Escanaba protests against the proposed enlarging of Chicago Drainage Canal. Such work would be incalcuable loss to all shipping interests of Lake Michigan. The commercialized damage to this city would be inestimable; the interests of the present and future generations demand the prevention of the proposed canal enlargement."

Telegram From the City of Petoskey, Michigan, to George A. Loud, February 26, 1912.

"Petoskey will expect you to fight attempt to take water from Lake Michigan for Chicago Drainage Canal. Amount already used has lowered level and hurt this city. Do your best."

Protest From the Mayor of Muskegon, Michigan, to the Secretary of War, March 13, 1912.

"In behalf of the City of Muskegon I wish to protest against the granting of the application of the Sanitary District of Chicago for authority to divert the waters of Lake Michigan to any greater extent than heretofore granted by the War Department. Muskegon is a growing city on the east side of Lake Michigan and about 110 miles northeast from the City of Chicago. It is situated on Muskegon Lake, which empties into Lake Michigan.

The lowering of the water level in Lake Michigan will injuriously affect the welfare of the city of Muskegon in many ways, but I will dwell shortly upon

The effect on the water system of said city,

The effect on the sewer system of said city,

The effect on the navigation interests of said city.

Muskegon has a water system situated on Lake Michigan from which it obtains its water supply. It has already expended nearly a half a million dollars thereon, and is now enlarging and improving this system to the extent of $300,000.00 more. The contracts are now made for new wells and new intake pipe and the work of construction has begun. The present intake pipe is out about 3900 feet from the shore line, but the new intake contracted for is to be placed about 7000 feet out. This change has been partly caused by the change of the level of Lake Michigan. The lowering of the lake level diminished the head of water and thereby decreased the flow of water into the wells from which we pump our supply. The cost of pumping the water has been increased due to the additional lift, and if the lake level should be diminished as contemplated by the Chicago Drainage Board it would become impossible to lift the water with our style of pumps. Any further lowering of the lake level will damage our water plant to such an extent that the engineers estimate the loss at upwards of $200,000.00.

Besides our water plant, there is the water plant of the city of North Muskegon situated on Bear Lake, which empties into Muskegon Lake. This would also be damaged.

On Muskegon Lake the Central Paper Mill Company has its own plant. This water plant, in the case of any further lowering of the lake level, would in all probability have to be rebuilt.

The sewer system of the city of Muskegon is all based upon outlets of the Muskegon Lake. These outlets are carried far enough into the lake so that the sewage is taken up by the current and distributed. The engineer informs me that if the lake level is diminished very much more a great many of these outlets will have to be taken up and relaid.

One of the most serious handicaps that would result from the further lowering of the lake level is this, that many boats could not reach the docks which they are at present using. Two docks in Muskegon Lake at which boats were accustomed to land have been abandoned in the last few years on account of the low water, and should the water level become still lower, many more of our old docks would have to be abandoned, or the owners would be put to an enormous expense of dredging alongside of these docks, and also in various spots where the lake is just sufficiently deep to allow some of our larger boats to pass at the present time.

Except in the cases above referred to, the entire depth of Muskegon Lake is now utilized, and any lowering of its surface involves the excavation of an artificial channel. It might mean eventually that open navigation on Muskegon Lake would be replaced by canal navigation.

* * * * * * *

Very truly yours,

Harry A. Rietdyk,

Mayor."

Protest from the Toledo Commerce Club to the Secretary of War, April 24, 1912.

"Inasmuch as there is before your department for consideration the request of the City of Chicago for a greater allowance of water through the Chicago drainage canal for the purpose of by that method satisfying the sanitary demands of the city, and inasmuch as we believe that the favorable consideration of this request would be fraught with detrimental results to the harbor of the City of Toledo, as well as the majority of

the harbors on Lakes Michigan, Huron and Erie, we take occasion to present the resolutions adopted by the Board of Trustees of the Toledo Commerce Club, as follows:

"Whereas the question of the level of the water in the Great Lakes and their connecting waters is of vital importance to the transportation facilities afforded by the harbor of Toledo, for the reason that any slight fluctuation of the water at the western end of Lake Erie and the lower end of Detroit river immediately affects the level of the water in the Maumee river which constitutes Toledo's harbor; and

Whereas the record of the water levels on the different lakes and channels shows that a slight fluctuation of the levels in Lake Michigan or Lake Superior results in a corresponding fluctuation of the levels of the lower lakes and connecting waters; and

Whereas our information is that the demand of the City of Chicago would tend to lower the level of Lake Michigan from six to eight inches, depending upon the amount of water abstracted by the growing demands of the city:

Be it resolved therefore, that this board does hereby seriously protest against the favorable consideration by the War Department on the request of the City of Chicago.

* * * * *

(Signed) J. D. Biggers,
Secretary."

Protest of the Cleveland Chamber of Commerce.

"Whereas the City of Cleveland is deeply interested in the development of navigation and commerce upon the Great Lakes; and

Whereas it has expended large sums in developing the harbor facilities of Cleveland and has asked and secured large governmental appropriations for harbor developments at Cleveland; and

Whereas any lowering of the lake level is likely to create necessity for additional expenditures to maintain the proper depth of water in harbors; and

Whereas it appears extremely probable that the subtraction of water from Lake Michigan through the Chicago Drainage Canal has been the cause, or a contributing cause the prevailing low depth of water during the season of navigation in 1911, and that any additional subtraction of water from Lake

Michigan would result in further lowering the level of the lower lakes:

Therefore be it resolved that the Cleveland Chamber of Commerce, representing the shipping and commercial interests of Cleveland, hereby protests against permission being granted to the Sanitary District of Chicago by the Secretary of War to increase the flow of water through the Chicago Drainage Canal beyond the amount of 4167 cubic feet per second, the quantity heretofore authorized.

Protest of Board of Control of Sandusky, Ohio, to Hon. Carl C. Anderson, February 24, 1912.

"The City of Sandusky through its Board of Control protest most emphatically against granting the application of the Sanitary District of Chicago for permission to divert 10,000 feet of water per second from the waters of Lake Michigan. The hearing will be given on the 28th at Washington, D. C.

May me ask you to see that this protest is properly registered."

(Signed by Clerk of Board of Control.)

Protest of Sandusky Business Men's Association, February 24, 1912.

"The Business Men's Association respectfully ask that you register our emphatic protest against the proposal to divert 10,000 feet of water per second from the waters of Lake Michigan upon the application of the Sanitary District of Chicago.

* * * * *

(Signed by the Secretary.)

Protest of the Buffalo Chamber of Commerce to the Secretary of War, April 1, 1912.

* * * * *

"The Buffalo Chamber of Commerce, representing the commercial interests of the City of Buffalo, realizing the injury to its commerce that the granting of the application would inflict in addition to the recognition of the right of a community to use the public waters for the purposes containing the commercial element to the detriment of other communities located on the lakes, seriously interfering with the use of the Great

Lakes as an avenue to transportation, does most earnestly register its protest against the granting of the application.

Government records show that up to June 30, 1911, federal authorities had spent at Buffalo and Black Rock in waterway improvements and in the maintenance of same, $7,932,380.68, and during the same period the citizens of Buffalo expended in the improvement of its harbor, $4,880,149.02, or a total of $12,812,529.70, which in itself is evidence of the importance of the Great Lakes to the commerce of Buffalo, and the necessity of avoiding any interference with the use of them as a factor in the developing of Buffalo commercially. The level of Lake Erie was one foot five inches lower in 1911 than in 1908, attributed not only to natural causes, but to the diversion of water from Lake Michigan under the present permit. This condition in the past few years has resulted in the lowering of the loading capacity of vessels, which has been reflected in the rates charged, causing loss not only to the shipping interests but to commercial interests as well, and as the tendency is to build larger and larger boats in order to reduce the transportation cost to a minimum, any action that will interefere with the operation of the large boats should be viewed as a public calamity.

The City of Buffalo stands ready to do its share toward providing harbor facilities that will permit its use by the largest vessels, but deem it an injustice that they be asked to increase this expense with no resultant compensation. We deeply feel that the granting of this application will work irreparable damage to the commerce of the City of Buffalo as well as other communities adjacent to Buffalo who use Lake Erie as a means to promote said commerce, and as other methods than that of dilution of sewage are now in vogue, and if all cities located on the Great Lakes should adopt the dilution method, it would nullify the use of the lakes for other purposes to the detriment of the people at large. Therefore, inasmuch as there are alternative methods that can be used for sanitation purposes, and the granting of the application would work a hardship on the citizens of Buffalo, we ask that a careful recognition of our views be given when the application should be finally considered.

Very respectfully submitted,

HARBOR AND RIVER COMMITTEE,
BUFFALO CHAMBER OF COMMERCE."

Resolution of Protest Adopted by Buffalo Lodge No. 1, Shipmasters' Association.

"Whereas the navigation of the Chicago river is at present extremely hazardous, dangerous and expensive for boats using the waterway, and

Whereas that undesirable state of affairs for boats is caused primarily through the necessity of supplying the Chicago Drainage Canal with the water it uses, and

Whereas the Chicago river "S" Branch is used to deliver the supply, thus creating a swift current which is constantly running, and

Whereas this supply is being drawn from Lake Michigan, thus increasing the flow from the lakes over its natural drainage which tends to lower lake levels, and

Whereas it is proposed to still further increase the drainage from the lake by building a canal to the Mississippi, or some point adjacent, and to supply the water necessary for said canal from the lakes through Chicago river and thus increase the hazard of navigation of Chicago river, and also lower lake levels, be it

Resolved that Buffalo Lodge No. 1, Shipmasters' Association, emphatically protest and oppose the said project of drawing more water from the lakes, or increasing the already dangerous current of Chicago river, and that this action be communicated to all sister lodges of this association and request their approval of the same, and that sister lodges send copy of this resolution to senators and congressmen of their respective districts and state.

W. E. Clark,
Chairman Harbor Committee."

Resolution of Ogdensburg Lodge No. 10, Shipmasters' Association.

"Whereas the navigation of the Chicago river is at present extremely hazardous and dangerous for boats using that water, and

Whereas that undesirable state of affairs for boats is caused primarily through the necessity of supplying the Chicago Drainage Canal with the water it uses, and

Whereas the Chicago river, south branch, is used to deliver the supply, thus creating a swift current which is constanly running, and

Whereas this supply is being drawn from Lake Michigan thus increasing the flow from the lakes over its natural drainage and tends to lower lake levels, and

Whereas it is proposed to still further increase the drainage from the lakes by building a canal to the Mississipppi or some point adjacent and to supply the water necessary for said canal from the lakes through the Chicago river and thus increase the dangers of navigation of the Chicago river and also lower lake levels, therefore be it

Resolved that Ogdensburg Lodge No. 10, Shipmasters' Association emphatically protest and oppose the said project of drawing more water from the lake or of increasing the already dangerous current of the Chicago river.

Respectfully submitted,

M. A. Leonard,
Secretary."

Protest of Lockport Board of Trade to Secretary of War, February 26, 1912.

Board of Directors of Lockport Board of Trade in special meeting assembled, this afternoon have directed me to advise you of our opposition to the proposed diversion of two thousand cubic feet of water per second for sanitary purposes at Chicago.

Such diversion could not fail to affect lake commerce as it would lower the level and furthermore the utilization of water forces for sanitation purposes is certainly the wrong practice, especially as such water forces are the source of municipal water supply.

We therefore wish to be recorded in opposition to the proposed diversion and beg to remain,

Yours very truly,

William A. Dickenson,
Secretary.

Protest of Mayor of North Tonowanda, New York, to the Secretary of War, February 24, 1912.

"* * * Our people are opposed to this application for the reason that it would have a tendency, however slight, to lower the waters of the Great Lakes to the great damage of navigation thereon and the government has expended millions

of dollars to improve navigation on the Great Lakes in order to take care of the greatest commerce on earth and anything which could in the slightest degree affect the level of the lakes will be an injury to our people and to the large majority of the people of the United States. * * *"

Telegram from Mayor of Tonowanda, New York, to the Secretary of War, February 27, 1912.

"* * * * We wish to advise you that our city and this section is opposed to any further diversion of lake waters for so-called sanitary purposes and we think Chicago has already done more than her share of damage to our lake channels on which the government has spent so much money. * * *"

Telegram from Fred E. Signer of Association of Lake Lines, February 19, 1912.

"* * * On behalf of the Association of Lake Lines using the Chicago river in package trade earnest protest is made against granting such application. The present current makes navigation difficult and any increase would seriously impair movement of vessels if not make impossible handling of goods to and from industries located on river. * * *"

Protest from Canadian Niagara Power Co. to Chief of Engineers, February 26, 1912.

"* * * The undersigned corporation, Canadian-Niagara Power Co., as the owner of certain water power rights on the Niagara river in the province of Ontario through grants from the Canadian government, claims and is enjoying the right to use the waters of that river at Niagara Falls for power purposes. This company respectfully objects to and protests against any diversion of the water of Niagara river or of the lake attributary thereto which shall impair or imperil the dominant rights of this company, the lower riparian owner, and it objects to and protests against any diversion of such upper water for power purposes."

Protest of Niagara Falls Power Company to Chief of Engineers, February 26, 1912.

"* * * This company respectfully objects to and protests against any diversion of the waters of the Niagara river or of the lakes attributary thereto which shall impair or imperil the dominant rights of this company, the lower riparian owner, and it objects to and protests against any diversion of such upper waters for power purposes.

Protest of Shenango Furnace Company, Pittsburg, Pennsylvania, to Secretary of War, February 26, 1912.

"* * * We hereby protest against any action on the part of the government which will further tend to reduce the level of any of the lakes.

During the year 1911 the critical points in the lake routes were six inches lower than the average level for the last fifty-one years.

There is invested in lake shipping some two hundred million dollars. Our company alone have invested in five ships amounting to over two million dollars. Carrying capacity of these vessels during the year 1911 was reduced over ten per cent., due to the lowering of lake levels by natural causes which must have been aggravated by the new outlet at Chicago."

Protest of City Council of Winchester, Illinois, to Secretary of War, March 18, 1912.

"* * * Whereas the Sanitary District of Chicago has petitioned the Secretary of War to increase the flow of water from Lake Michigan down the path of the Illinois river, and believing such action would cause an overflow of the Illinois river, doing immense damage to land tributary to this city, causing a great financial loss to this city and county be it therefore

Resolved that we protest against such action by the War Department until the same can be done without damage to the land owners of the Illinois river valley. * * *"

PROTEST OF ASSOCIATION OF DRAINAGE AND LEVEE DISTRICTS OF ILLINOIS

Directors

Jesse Lowe, Beardstown, Ill.
Edward Boyle, 218 LaSalle St., Chicago, Ill.
Eugêne Brown, Peoria, Ill.
C. W. Brown, Jacksonville, Ill.
W. F. Roegge, Meredosia, Ill.
C. J. Lumpkin, Carlinville, Ill.
H. B. Atkinson, New Canton, Ill.
H. V. Teel, Rushville, Ill.
H. J. Marsh, Naples, Ill.

Committee on Legislation

C. W. Brown, Jacksonville, Ill.
Thos. Worthington, Jacksonville, Ill.
Jacob A. Harmon, Peoria, Ill.
C. J. Lumpkin, Carlinville, Ill.
F. A. Whitesides, Carrollton, Ill.
W. K. Curran, Pekin, Ill.

Committee on Resolutions

T. E. Bottenberg, Rushville, Ill.
Lyman E. Cooley, Chicago, Ill.
V. P. Turner, Pekin, Ill.

Committee on Membership

Henry L. Wood, Sheffield, Ill.
W. J. Graham, Aledo, Ill.
A. H. Bell, Bloomington, Ill.

H. J. Puterbaugh, President, Mackinaw, Ill.
Louis Lowenstein, First Vice-President, Whitehall, Ill.
H. B. Atkinson, Second Vice-President, New Canton, Ill.
Guy L. Shaw, Secretary, Beardstown, Ill.
Secretary's Office
Beardstown, Illinois,

RESOLUTIONS PASSED BY THE ASSOCIATION OF DRAINAGE AND LEVEE DISTRICTS OF ILLINOIS

In Session at Springfield, Illinois, March 8th, 1912

Objecting to Increased Flow in Illinois River from [of] Water from Lake Michigan

1. WHEREAS, The turning into the valley of the Illinois river of waters from Lake Michigan by the Sanitary District of Chicago has caused great damage to the valley by overflowing valuable farming and timber lands and rendering them unproductive and unsanitary, and

2. WHEREAS, This great damage has been caused by the flow of less than 4,200 cubic feet per second, and

3. WHEREAS, The Sanitary District of Chicago is now asking the Secretary of War for a permit to increase the flow from Lake Michigan, down the path of the Illinois River, to 10,000 cubic feet per second, and

4. WHEREAS, Such flow will increase the damage done to the Illinois valley lands, and

5. WHEREAS, No provision has been made to prevent the damage that has been created by the flow from Lake Michigan, as exists now, to say nothing of the proposed increase, by either the Sanitary District of Chicago or the State of Illinois or the Federal Government, by the preparing of the channel of the Illinois River through the alluvial valley to care for same without damage, and

6. WHEREAS, 400,000 acres of the lands of the valley and numerous cities and villages are affected and damaged by the present flow and will be proportionately more damaged by the increased flow, and

7. WHEREAS, Great increase in cost to reclaim these lands and maintain the reclamation of the lands already reclaimed entailing cost to the thousands of land owners that can only be reimbursed by long expensive litigation, and

8. WHEREAS, The proper regulation of rivers of the United States is vested in the FEDERAL AUTHORITIES OF THE UNITED STATES, and any artificial changes of the natural conditions can only be made by authority of the Federal authorities and we cannot believe that it is any part of the policy of the United States either by sin or omission to damage the great

riparian interests in the lower valley or to prevent or handicap the development by reclamation of lands or their maintenance. On the contrary we look to the Federal authorities to remedy the present situation and to prevent further destruction of property. And recognizing the great authority of the United States in this matter,

9. THEREFORE, We respectfully represent that any higher water level in the river, which would be occasioned by this increased flow, would not only greatly damage and in many cases ruin the land owner, who has at great expense put such lands in cultivation, but also would render practically worthless hundreds of thousands of dollars of registered bonds, issued against said lands to pay for the reclamation of the same, many of which bonds are held in small amounts by investors of moderate means; therefore, be it

10. RESOLVED, By the Association of Drainage and Levee Districts of Illinois, in extraordinary session assembled, this 8th day of March, 1912, at Springfield, Illinois: That we protest against the granting of the permit for a greater flow through the valley of the Illinois river, and pray that no farther increase be allowed until the dams are removed and the channel so improved that the increased flow may be accommodated without damage to the lands of the valley and navigation be maintained. Be it further

RESOLVED, That this Association co-operate with all other interests affected by the improvement of the channel of the Illinois; and that a copy of these resolutions be transmitted to the secretary of war, to the chief of engineers of the United States army, the Governor of the state of Illinois, and all other interests affected.

Protest from Citizens of Chillicothe, Illinois.

"To the Honorable Henry L. Stimson,
Secretary of War,
Washington, D. C.

We, the undersigned owners of land adjacent to the Illinois river and citizens of the Illinois Valley in and near the City of Chillicothe, in the County of Peoria and State of Illinois, do hereby earnestly protest against and object to the granting of the petition of the Sanitary District of Chicago, in which they ask to be allowed to increase the water discharged by means of the Sanitary District canal from 3,200 ft. per second to 10,000 ft. per second.

We would respectfully show that the amount of water now discharged by said Sanitary District canal into the Illinois river has raised that river so as to cause its water to remain over the bottom lands much longer each year than formerly. It has caused vast areas of timber to die and has seriously impaired, if not entirely destroyed, the usefulness of many farms and large areas of land.

We would further show that it has entailed large expense upon those who have attempted to protect their lands by levees, in that it has imposed upon districts already formed, the necessity of increasing the size and height of their levees and the additional cost of pumping the water from such district against the increased amount of water in the river.

We would further respectfully protest against the granting of the prayer of said petition for the reason that said Sanitary District has not complied with the provisions of the statute with reference to compensation for lands damaged by reason of such overflow and resist the payment of such damage in such manner as to make it more expensive for the small land owner to recover his rights than he can afford.

All of which is respectfully submitted.

Wm. M. Mead,
President Business Men's Asso. Chillicothe, Peoria Co., Illinois.

C. B. Zinser,
Treasurer, Business Men's Asso.

D. Kelly,
Chairman Partridge Drainage Dist., Chillicothe, Ill.

B. F. Zinser,
Pres. First National Bank, Chillicothe, Ill.

Ellis Kiser,
Com. of Crow Creek Drainage Dist.

Truett Matthews & Co.,
Bankers."

Protest of H. and E. F. Hunter, Chillicothe, Illinois, to the Secretary of War, March 12, 1912.

"As large owners of Illinois river bottom lands, we wish to enter our protest against permitting the Chicago Sanitary District to increase the flow of water through the Sanitary Canal from Lake Michigan. These Illinois river lands which

are among the most fertile in the world have already been seriously injured by the increased flow of water, damages for which can only be had after long and expensive litigation with the Sanitary District. This litigation is so expensive that it puts it practically beyond the range of the ordinary small land owner to get redress. We can see no reason why the residents of this valley should be subjected to all this loss for the sake of disposing of sewage which could be well taken care of in a better and more scientific way."

Resolution of Protest, City of Beardstown, Illinois.

"The following resolutions were adopted by the City Council, of the City of Beardstown, Illinois, at a regular meeting of the Council held Tuesday, March 5th, 1912, with instructions for the City Clerk to mail a copy of the said resolutions signed by the Mayor and City Clerk under the seal of the City of Beardstown to the Executive officers of the United States, Committee of Congress, Members of the National Congress and Senate from the State of Illinois and the Sanitary District of Chicago, to the Lakes-to-the-Gulf Deep Waterway Association, the Governor of the State of Illinois, the Rivers and Lakes Commission, the Mayor of Chicago, the Trustees of the Sanitary District of Chicago and the State Canal Commission, and others who may be particularly interested.

Whereas, The Sanitary District of Chicago, is now importuning the Secretary of War, to issue a permit, permitting an increase from 4,166 cubic feet per second to 10,000 cubic feet per second in the flow of waters from Lake Michigan down the Illinois river, and

Whereas, The present flow has caused an enormous amount of hardship and damage to the City of Beardstown and its inhabitants and to surrounding lands to say nothing of what an increase flow will mean, now

Therefore, be it resolved by the City of Beardstown through the Mayor and City Council that they hereby protest against such permit being issued, until the Illinois river is so improved by dredging and removal of locks and dams as to fit it to take care of the present flow, and that now asked for.

H. C. Keil,
Mayor."

(Seal)
Attest:

R. B. Maslin,
City Clerk.

Resolution of Protest by Beardstown Chamber of Commerce.

"Whereas, The turning into the valley of the Illinois river of waters from Lake Michigan by the Sanitary District of Chicago has caused great damage to the valley by overflowing valuable farming and timber lands and rendering them unproductive and unsanitary, and

Whereas, This great damage has been caused by the flow of less than 4,000 cubic feet per second, and

Whereas, The Sanitary District of Chicago is now asking the Secretary of War for a permit to increase the flow from Lake Michigan, down the path of the Illinois river, to 10,000 cubic feet per second, and

Whereas, Such flow will increase the damage done to the Illinois valley lands, and

Whereas, No provision has been made to prevent the damage that has been created by the flow from Lake Michigan, as exists now, to say nothing of the proposed increase, by either the Sanitary District of Chicago or the State of Illinois or the Federal Government, by the preparing of the channel of the Illinois river through the alluvial valley to care for same without damage, and

Whereas, 400,000 acres of the lands of the valley are affected and damaged by the present flow and will be proportionately more damaged by the increased flow, and

Whereas, Great increase in cost to reclaim these lands and maintain the reclamation of the lands already reclaimed entailing cost to the thousands of land owners that can only be reimbursed by long and expensive litigation, and

Whereas, The proper regulation of rivers of the United States is vested in the federal authorities of the United States, and any artificial changes of the natural conditions can only be made by authority of the federal authorities and we cannot believe that it is any part of the policy of the United States either by sin or omission to damage the great riparian interests in the lower valley or to prevent or handicap the development by reclamation of lands or their maintenance. On the contrary, we look to the federal authorities to remedy the present situation and to prevent further destruction of property. And recognizing the great authority of the United States in this matter, Therefore be it

Resolved, That the Chamber of Commerce of the City of Beardstown, Cass County, Illinois, do hereby protest against the granting of any permit to increase the flow of waters of Lake Michigan down or through the valley of the Illinois

River until after such time as the lower reach of the Illinois river is properly prepared to receive the same without damage to the lands of the valley and the agricultural and commercial interests; and be it further

Resolved, That the President and Secretary of this Chamber of Commerce are hereby directed to send copies of these resolutions to the Executive officers of the United States, Committees of Congress, Members of the National Congress and Senate from the State of Illinois, and the Sanitary District of Chicago, to the Lakes-to-the-Gulf Deep Waterway Association, the Governer of the State of Illinois and others who may be particularly interested.

Dated at Beardstown, Illinois, March 5th, 1912.

H. G. Russell,
President.

(Seal)
The Beardstown Chamber of Commerce
Illinois (Seal) Beardstown

H. Lerkewich,
Secretary.

Letter of Protest of Charles Schaaf to Secretary of War, February 23, 1912.

"I notice in the paper that on Feb. 28th you will give a hearing to the Sanitary District of Chicago for permission to divert an additional 10,000 cubic feet of water into the drainage canal. I wish to complain and say that the Sanitary District company has overflowed my land so that I am unable to make more than a living and if they are permitted to turn in more water my place will be a total loss. Before this water was turned in I could raise four or five thousand bushels of corn every year, now I do well to average one thousand a year—ten years ago my place was worth fifteen thousand dollars and now I would be *only to glad to sell for five thousand.* They ought to buy this bottom land before they are allowed to turn in the water. You may say sue them. Why we have been trying to sue them for 10 years but what can us poor farmers do with a company that is worth 50 to 60 millions, (*nothing?*) So I ask you in the name of God to not let them turn in more water, thanking you for any favors, believe me to be. * * *

Charles Schaaf."

Protest of City Council of Rushville, Illinois, Dated March 5, 1912.

"Whereas, The turning into the valley of the Illinois river of waters from Lake Michigan by the Sanitary District of Chicago has caused great damage to the valley by overflowing valuable farming and timber lands and rendering them unproductive and unsanitary, and

Whereas, This great damage has been caused by the flow of less than 4,000 cubic feet per second, and,

Whereas, The Sanitary District of Chicago is now asking the Secretary of War for a permit to increase the flow from Lake Michigan down the path of the Illinois river, to 10,000 cubic feet per second, and,

Whereas, Such flow will increase the damage done to the Illinois valley lands, and

Whereas, No provision has been made to prevent the damage that has been created by the flow from Lake Michigan as exists now, to say nothing of the proposed increase, by either the Sanitary District of Chicago or the State of Illinois or the Federal Government, by the preparing of the channel of the Illinois river through the alluvial valley to care for same without damage, and,

Whereas, 400,000 acres of the lands of the valley are affected and damaged by the present flow and will be proportionately more damaged by the increased flow, and,

Whereas, Great increase in cost to reclaim these lands and maintain the reclamation of the lands already reclaimed entailing cost to the thousands of land owners that can only be reimbursed by long and expensive litigation, and,

Whereas, The proper regulation of rivers of the United States is vested in the *federal authorities of the United States* and any artificial changes of the natural conditions can only be made by authority of the federal authorities and we cannot believe that it is any part of the policy of the United States either by sin or omission to damage the great riparian interests in the lower valley or to prevent or handicap the development by reclamation of lands or their maintenance. On the contrary we look to the federal authorities to remedy the present situation and to prevent further destruction of property. And recognizing the great authority of the United States in this matter, Therefore,

Be it, Resolved, That the City Council of the City of Rushville in Schuyler County, Illinois, do hereby protest against the granting of any permit to increase the flow of waters of

Lake Michigan down or through the valley of the Illinois river until after such time as the lower reach of the Illinois river is properly prepared to receive the same without damage to the lands of the valley and the agricultural and commercial interests."

Letter of Smith-Hippen Co., Pekin, Illinois, to Chief of Engineers, February 27, 1912.

W. H. Bixby,
Chief of Engineers, U. S. Army,
Washington, D. C.

Dear Sir:—

Your message of the 21st and letter of the 22nd refering to the hearing before the Secretary of War on the 28th, received. Referred same to a meeting of land owners and commissioners of the various drainage districts in this vicinity such as we could gather together and at their request wired you if it would not be possible to secure a postponement of the hearing or reserve the decision until a statement of the conditions could be prepared with a protest against increasing the present flow from Lake Michigan. Not hearing from you we suppose it was impossible for you to get this concession.

We know that if the lands owners and drainage commissioners are given a chance to make a protest, that they can demonstrate that the increased flow of water in the Illinois river without a corresponding depth of channel to provide for it will inculcate great loss on all of the drainage districts now organized or in the process of organization.

As a firm we now have invested in elevators along the Illinois river about $75,000.00. These houses were located and built on the basis of high water before the turning in of the extra water from Lake Michigan. This past year we were compelled to change our system of unloading at our Pekin elevator at a cost of over $1,100.00 because the increased floods each year overflowed our conveyors and rendered impractical this means of unloading boats which had been operated for years without any trouble with floods.

We find now that when the river is at flood state that the water is up over our foundations at practically every elevator and any increase in the volume of the water put it into all of our bins with a chance of great possible loss to both the buildings and their contents.

A further increase of water would mean that every river

house that we own would either have to be rebuilt or entirely remodeled and all approaches raised so as to get above any possible action of the water.

As most of the grain reaching our river houses is hauled over bottom roads, these would also have to raised a corresponding amount or our business would be hampered and handicapped by the longer period in which the flood water would submerge the roads.

The great difficulty with the flow of water from the drainage canal is that it is regulated entirely to suit the needs of the Sanitary District without regard to the loss or inconvenience to the river valley.

We find that the time of our greatest floods is the time at which the greatest amount of water is passed over the bear trap. Quoting from the Chicago Evening Post of April 30, 1909—"Flow in the drainage canal nearly doubled to meet emergency of record-breaking rainfall." And again from the same issue—"In the sanitary canal the flow first was increased from a normal of 350,000 cubic feet of water a minute to 480,000 cubic feet, and when that augmented flow failed to keep the river current flowing away from Lake Michigan, instructions were phoned to Lockport to lower the dam still farther to permit 600,000 cubic feet to pass over it each minute."

There are no records accessible to us by which we can prove these figures but we do know that our floods are augmented each year very considerably by the excessive amount of water let in through the drainage canal and a further increase of this amount would work us very serious damage.

We would welcome the time when ten thousand second feet of water could be passed down this river if the channel were prepared to receive it, but with conditions as they are at present we think it would be of great loss to all of the valley interests to increase the flow.

Yours very truly,

SMITH-HIPPEN COMPANY,

by A. J. AYDELOTT."

Protest of Citizens and Property Owners of Greene County, Illinois, to the Secretary of War, March, 1912.

"We, the undersigned citizens residing in Greene County, Illinois (which borders on the Illinois river), do hereby most earnestly protest against the granting of permission to the Sanitary District of Chicago to turn into the Illinois river valley any greater amount of water than the present flow of 4,200 cubic feet per second, until such time as by reason of the removal of the dams and other obstructions now in said river, a sufficient channel will be prepared to accommodate such increased flow without the great damage to agricultural and other interests that would necessarily result from such increased flow with the river in its present condition.

In support of this protest we respectfully call your attention to the fact that this increased volume of water is not needed for the purposes of navigation: that there are in our county thousands, and in the valley of the Illinois tens of thousands, of acres, of rich farming lands now in cultivation and highly productive, which by reason of their low elevation will be practically ruined in case the water level in the river is materially increased, and especially is this true by reason of the fact that the dams across the river have already raised the level at low water to a point which approaches the natural level of those lands. We most respectfully insist that the increased water level in the river, which would be occasioned by this additional flow, would not only greatly damage, and in many cases financially ruin, the land owners, who have, by years of unremitting toil and privation and the expenditure of vast sums of money, converted these lands from their natural condition of swamps into fertile and productive fields, but would also render practically worthless millions of dollars of drainage bonds which have been issued against these lands to pay off the cost of building levees, excavating ditches and installing pumping plants, etc., many of which bonds are held in small amounts by investors of moderate means, some of whom have the savings of a lifetime invested in them.

We therefore most earnestly request you to withhold your official permission to the turning into this fertile valley of this great increase of water, which, under present conditions, would be bound to cause such great and irreparable loss and damage to so many of our citizens.

All of which is respectfully submitted."

United States of America, }
Northern District of Illinois, } ss.
Eastern Division. }

IN THE DISTRICT COURT OF THE UNITED STATES.

United States of America,
Complainant,
vs.
The Sanitary District of Chicago,
Defendant.
} Equity No. 114.
C. C. No. 29,019.

STIPULATION.

It is hereby stipulated that the matter on pages 3601 to 3845, inclusive, being extracts from public hearings, briefs, letters, telegrams, and resolutions in connection with the application of the Sanitary District of Chicago of February 5, 1912, to divert 10,000 cu. ft. of water per second from Lake Michigan, may be considered in evidence with like effect as if witnesses were called and originals were produced and identified in this case, subject to all objections as to materiality, relevancy and competency, but neither complainant nor defendant waives by this stipulation any objections as to competency, relevancy and materiality of any similar or like matters offered by the other party relative to said hearing.

CHAS. F. CLYNE,
United States Attorney.
EDMUND D. ADCOCK
Attorney for Sanitary District of Chicago.

Chicago, October 1st, 1914.

EXTRACTS FROM APPROVALS OF VARIOUS ASSOCIATIONS AND INDIVIDUALS, AND BRIEFS ON BEHALF OF THE STATE OF ILLINOIS AND THE CITY OF CHICAGO.

Letter of Approval by Major Thos. H. Rees, U. S. Engr., to Chief of Engrs. U. S. Army, Jan. 17, 1910.

"1. In connection with 1st indorsement of this date on letter from Chief Engineer, Sanitary District of Chicago of

January 10, 1910, I have the honor to submit the following report and recommendations:

2. The only questions in connection with this application that seem to require consideration by the War Department are the following:

(a) The reversal of the flow of water in the Calumet River.

(b) The change of hydraulic grade in the Calumet River.

(c) The velocity of current that may be generated in Calumet River.

(d) The diversion of water from Lake Michigan.

3. Although not stated in the application, I am informed by the Chief Engineer of the Sanitary District that it is proposed to provide for a flow in Sag Channel—of 2,000 cubic feet per second. The natural flow in the Calumet River varies between wide ranges and is largely affected by the stage of Lake Michigan. The drainage basin has an area of 825 square miles and the mean annual rainfall of this region is 33 inches. Assuming a run-off of 40 per cent. the average discharge of the river would be 800 cubic feet per second. During dry periods the discharge is practically nothing and a temporary rise in lake level sometimes causes a current up-stream. During freshets the discharge is greatly increased and may at times greatly exceed the 2,000 cubic feet per second proposed to be diverted into the Sag-Channel. At such times the surplus would discharge into Lake Michigan without any reversal of flow in the lower Calumet River. A large part of the sediment and sewage from the Grand Calumet and Little Calumet rivers would be carried into the Sag-Channel, thus diminishing the deposits of such material in the lower Calumet River and in Calumet Harbor. The reversal of flow in Calumet River would not be detrimental to navigation interests provided the reversed current has a moderate velocity.

4. A reversal of the flow in the Calumet River will necessarily cause a downward slope of the water surface from the Lake toward the Sag-Channel, thus lowering the hydraulic grade and slightly diminishing the depth of water in the channel. In the existing channel a flow of 2,000 cubic feet per second will cause a slope of about 1:1,000,000 and at "the Forks," which is the head of projected improvements, the hydraulic grade would be lowered only about 0.4 of an inch. This is negligible and the lowering of the hydraulic grade would not be prejudicial to navigation.

5. A flow of 2,000 cubic feet per second would generate in the existing channel a mean velocity not exceeding 0.45 feet

per second (0.3 miles per hour). Through bridge openings 120 feet wide the mean velocity would be about 0.83 feet per second (0.55 miles per hour). These velocities would not be detrimental to navigation interests.

6. It seems to have been conceded both by the War Department and by the International Waterways Commission that, subject to possible future action by the Courts or the Congress of the United States and to possible treaty stipulations with the Dominion of Canada, the Sanitary District of Chicago may divert from Lake Michigan through its Sanitary and Ship Canal, 10,000 cubic feet of water per second and no more, provided the currents thereby generated in navigable channels of the United States shall not be unduly harmful to navigation interests by reason of excessive velocities. The several outlets through which the Sanitary District proposes to effect this diversion are: The North Shore Channel from Lake Michigan at Wilmette, Ill., to the North Branch of Chicago River at Lawrence avenue (authorized and under construction); the Chicago River together with the South Branch and West Fork to Robey street (authorized and nearly completed); the 39th Street Conduit and pumping station (in operation); the Calumet River by means of the proposed Sag-Channel from the Little Calumet River at Blue Island to the main drainage canal at Sag. If the total diversion through all of these outlets be limited to 10,000 cubic feet per second and if the currents be restricted to harmless velocities, I can see no reason, so far as the interests of navigation are concerned, for denying this application of the Sanitary District of Chicago.

7. It is therefore recommended that this application of the Sanitary District of Chicago be granted subject to the following conditions:

1. That the total diversion of water from Lake Michigan by the said Sanitary District through all of its channels and outlets shall not exceed the rate of 10,000 cubic feet of water per second.

2. That the current generated in any navigable channel of the United States used in part for such diversion of water from Lake Michigan shall not have a mean velocity exceeding one and one-quarter (1¼) miles per hour.

3. That detailed plans showing the proposed location and method for the connection of the Sag-Channel with the Calumet or Little Calumet River and showing also any changes or alterations proposed to be made in said rivers shall be sub-

mitted by the Sanitary District for prior approval by the War Department, and this part of the work shall be subject to supervision by the U. S. Engineer Officer whose address is Chicago, Ill.

4. That this permission shall not be construed as authorizing the invasion of any legal rights of corporations or individuals, municipal or private, or as exempting the grantee from responsibility for damages that may result from the works herein authorized.

Thos. H. Rees,
Major, Corps of Engineers."

Letter of Approval by Major Thos. H. Rees, U. S. Engr., to Chief of Engr., U. S. Army, Feb. 21, 1910.

"1. Replying to your letter of February 16, 1910 (E. D. 28918/265), in regard to the application of the Sanitary District of Chicago for permission to divert water from Lake Michigan through a proposed Calumet-Sag Channel, I have the honor to refer to the report of Colonel W. H. Bixby, Corps of Engineers, of December 4, 1906, from which I quote, 'so far as it provides for keeping a part of the Calumet Basin sewage from flowing into Lake Michigan and for diverting the same into the Sanitary District Canal and Illinois River the project deserves all reasonable and allowable commendation and encouragement. * * * The reasons given oblige me at present to recommend against any present favorable consideration of the present request unless the 10,000 cubic feet per second flowage possibly allowable through the Chicago River be reduced by the amount allowed to the Calumet. Otherwise I see no special objection to the permit as requested so far as concerns the interests of navigation.'

2. The recommendations of the Chief of Engineers of February 23, 1907, quoted by the Secretary of War in his memorandum of March 14, 1907, refer to the conclusions of the International Waterways Commission as set forth in report of January 4, 1907, printed as War Department Document No. 293. This report concludes with the following words:

'We therefore recommend that the Government of the United States prohibit the diversion of more than 10,000 cubic feet per second for the Chicago Drainage Canal.'

3. On May 4, 1906, the Secretary of War transmitted to the President for submission to Congress a report of May 3, 1906,

by the International Waterways Commission upon the preservation of Niagara Falls printed as Senate Document No. 434, 59th Congress, 1st Session in which 'The Comission therefore recommend that * * * a diversion for sanitary purposes not to exceed 10,000 cubic feet per second be authorized for the Chicago Drainage Canal. * * *'

4. I cannot find any definite concurrence by the Chief of Engineers or the Secretary of War in the conclusions and recommendations of the International Waterways Commission above quoted but the 'conclusions' were referred to by the Chief of Engineers to support his recommendations and the 'recommendations' were transmitted by the Secretary of War for submission to Congress without adverse comment. Therefore I stated in my letter of January 17, 1910, that it seems to have been conceded by the War Department that the Sanitary District may divert from Lake Michigan through its Sanitary and Ship Canal 10,000 cubic feet of water per second.

5. The former application of the Sanitary District which was denied in March, 1907, asked for approval of plans which contemplated an ultimate total diversion of 14,000 cubic feet of water per second from Lake Michigan. The application of January 10, 1910, contemplates a total diversion of 10,000 cubic feet per second.

THOS. H. REES,
Major, Corps of Engineers."

Letter of Approval by P. T. Cook to Secretary of War, Feb. 29, 1912.

"Subject, Increasing Second-Feet to Chicago Drainage Canal.—Sir: I am a student of the Great Lakes since 1875, when I began to hunt and fish on St. Claire Flats. My Indian and half-breed punters instilled the notion that there was a regular cycle of high and low water of about eleven years from crest to crest, with a difference of two to three feet. My personal experience was the purchase of a low lying farm on Huron Point, Lake St. Claire, and its sale several years later. When I bought, the farmer had been drowned out for a couple of years. When I sold, the entire farm could be plowed to the shore of the lake.

I think I have read of this cycle in the writings of Schoolcraft and Cass. I have heard it from the boatmen at Mackinac, and my guides on Superior. My own opinion is that the

cycle is irregular and dependent on the rainfall of the Great Lakes basin. A comparison of the rainfall from the records of the Weather Bureau with the gauge readings of the upper lakes should verify or disprove the tradition.

Twenty-five years ago, Capt. Lockwood, then in charge of rivers and harbors at this point, estimated the northward current on the east side of Lake Michigan at one-quarter to one-half mile per hour.

At the slowest rate, the 7,000 second feet now allowed the Drainage Canal would deduct 0.1416 feet from a width of twenty-five miles, and reduce the level of the lake 0.04423 feet or one-half inch.

Assuming locks 150 feet wide, 900 feet long with 22 feet over sill and assuming that lockages are made continuously at the average rate of those at Sault Ste. Marie for 1909, 35 Min., and allowing 30 per cent. displacement, 2,315 second-feet would supply the water, leaving 4,685 feet for power.

As the present supply gives a speed of two and one-half miles per hour in the rock-cutting sections of the canal, it is evident that the call for more water comes only from the neighborhood of the turning basins and from the waterwheels at Lockport.

If it should be found necessary to give some water for the basins, I respectfully suggest that the amount be limited to 2,500 feet, and the proviso be inserted in the grant that this extra amount shall, at all times, be available for ship canal use, and that no vested rights shall accrue by reason of its use for other purposes, no matter how long such use may become.

As to the effect on the climate of Michigan, the fears of my neighbors are groundless.

One illustration is enough. The Hon. William Livingstone is quoted, this morning, as saying: 'Lake Superior has fallen .8 foot in the last four years, Lakes Michigan and Huron .8 foot in two years, Lake Erie a .8 foot in two years and Lake Ontario 1.5 feet.'

The fact that Superior, Michigan and Huron show the same drop is conclusive proof that the canal is no factor in the lake level.

P. T. Cook."

Letter of Approval by Illinois Rivers and Lakes Commission
March 11, 1912.

"In connection with the request of the Sanitary District of Chicago for permission to extract a volume of ten thousand cubic feet of water per second from Lake Michigan, the Rivers and Lakes Commission of the State of Illinois begs to submit for your consideration the following statement of facts:

First: This volume of water is required in order to comply with the laws of Illinois.—Sanitary District Act of Illinois General Assembly, 1889.

Second: The connection between the Great Lakes and the Mississippi Valley was provided for by Congressional Act in 1832, as held by the Supreme Court of the United States in the case of Missouri *vs.* Sanitary District of Chicago.

Third: That the Sanitary and Ship Canal, as constructed, is of a size necessary under present conditions to carry out the waterway policy of the United States formed in 1832.

Fourth: The full project of the State of Illinois contemplates the sanitation of Chicago and of the Illinois River valley; the construction of a navigable waterway giving to this region facilities similar to those provided by the United States Government in the Ohio River and in the St. Mary's and other interlake channels, the same to be paid for so far as possible out of the water power created as incident to the work.

Fifth: We call your attention that this is a project distinctly in accordance with present-day views as to the use of public property for the general welfare and shows a marked advance over the methods heretofore used in creating public improvements.

Sixth: Opposition to this plan comes from and is urged in behalf of special interests, which derive almost exclusive benefits from the Government appropriations for the Great Lakes, whether spent in deepening channels, building locks or improving harbors.

Seventh: For entire confirmation of these facts, we refer you to the arguments of Mr. Isham Randolph, Mr. Gardner S. Williams and Mr. Robert R. McCormick.

ROBERT R. MCCORMICK,
Chairman."

Letter of Approval by Senator S. M. Cullom, March 20, 1910.

"I have just received the enclosed resolution adopted by Board of Trustees of the Sanitary District of Chicago, in reference to the increase in the flow of waters made necessary by the proposition to reverse the flow of the Calumet. It seems to me that there is merit in the proposition that a permit should be granted along the lines asked for by the Drainage Board.

I send the resolution to you, to again call your attention to the matter, in the hope that you may see your way clear to grant the permit requested.

Sincerely yours,

S. M. Cullom."

Resolution of Approval by Chicago Association of Commerce.

"We respectfully invite your attention to the attached certified copy of a resolution adopted today by the Executive Committee of this Association with respect to the application of the Board of Trustees of the Sanitary District of Chicago to take additional water from Lake Michigan.

The Chicago Association of Commerce,

By E. U. Kimbark,

President."

Resolution Adopted by the Executive Committee of the Chicago Association of Commerce in Regular Meeting Assembled on Friday, March 22, 1912.

"Whereas, the Board of Trustees of the Sanitary District of Chicago has petitioned the United States Government for an increased flow from Lake Michigan of from 4,167 cubic feet per second to 10,000 cubic feet per second, of which 2,000 cubic feet is to come through the Calumet River into the Drainage Canal, 2,000 feet through the tunnel leading from the Lake at 39th street and connecting with the Drainage Caral, and 1,000 cubic feet forced through the opening from the Lake to the North Branch of the Chicago River; therefore be it

Resolved, That the Executive Committee of the Chicago Association of Commerce approves the granting of said increase, provided it shall not become operative until after the

improvements in the channel are completed, namely, a width of 200 feet and a depth of 26 feet, with the exception of the modifications as to width heretofore made by this committee; and with the further provision that the flow of water is to be restricted by the United States Government in the event of undue interference with the navigation interests of Chicago.

I, H. F. Miller, business manager of the Chicago Association of Commerce, do hereby certify that the above is a true copy of a resolution adopted by the Executive Committee of the Chicago Association of Commerce at a regular meeting held on Friday, March 22, 1912.

H. F. MILLER,
(SEAL) *Business Manager.*"

Letter of Gov. Chas. S. Deneen of Illinois, March 25, 1912.

"I have requested Mr. Isham Randolph, to whom I have handed this letter, to represent the interests of our state at the hearing which he is to appear before you regarding the question of the diversion of water from Lake Michigan for the use of the Sanitary District of Chicago.

Mr. Randolph was a member of the Illinois Internal Improvement Commission and represented our state at certain conferences with the Board of Army Engineers, appointed by the Sixty-first Congress, in its investigation of the improvement of the lower Illinois River and is at present a member of the Illinois River and Lakes Commission.

C. S. DENEEN,
Governor."

Argument on Behalf of The State of Illinois Supporting the Prayer of The Sanitary District of Chicago for a Permit to Take 10,000 *Cubic Feet of Water Per Second from Lake Michigan, April* 3, 1912.

"To the Honorable Secretary of War:

As a preface to the appeal which I am about to make to your reason and your sense of justice, I shall in the briefest way recite a few historic facts.

Lake Michigan in order of magnitude stands third in the roster of the Great Lakes, with an area of 22,326 square miles. This body of water belongs wholly to the United States and is allotted to the several states which bound it as

follows: Indiana, 230 square miles; Illinois, 1,674 square miles; Wisconsin, 7,500 square miles; and Michigan, 12,922 square miles. (See Statistical Abstract of the United States for 1907, page 19.) In these waters, the treaty of Washington, 1871, gave the citizens of Great Britain equal rights of navigation with the citizens of the United States subject to the laws of the State bordering thereon. This treaty terminated by its own limitation in 1881 and thereafter the citizens of Great Britain had no treaty rights in these waters but were by courtesy accorded all the privileges they enjoyed under the treaty. And thus it has been until the promulgation on May 13, 1910, of the now existing treaty.

The history of Chicago is not ancient for only one hundred years have elapsed since the Fort Dearborn massacre. Modern as it is, however, it is crowded with incident. Chicago was incorporated in 1837 with a population of about four thousand. When the great fire of 1871 swept the city, the population was about three hundred and twenty-five thousand. Today, nearly forty-one years after the fire, the population has reached two million two hundred and fifty thousand. The source of water supply for this great city is and has been since its inception, Lake Michigan. For a long term of years that great reservoir was also the receiver of the sewage of the city and it was only when the waters became so foul as to produce disease that an effort was made to safeguard the water supply. The steps which led up to this effort and the details of its successful issue cannot be recounted here. The Chicago Sanitary and Ship Canal was dug and the flow of the Chicago River was caused to turn backward and through that once foul channel, the waters of Lake Michigan are flowing towards the Gulf of Mexico.

The legislation by the State of Illinois which authorized this great work had wide notoriety. The Sanitary District law which went into effect July 1, 1889, was widely advertised; its constitutionality was attacked but it was sustained by the courts. All of this was known to the Congress of the United States and to the executive departments of the Government and from no one of these did there come a protest to a prosecution of the work which was commenced Sept. 3, 1892. That work was prosecuted diligently for eight long years with the full knowledge of every department of the United States Government. The work was visited by Congressional delegations; by Secretaries of War; by Chiefs of Engineers, by officers of the United States Engineer Corps;

and no voice was raised in opposition. Literature describing the work was scattered broadcast. I myself sent out thousands upon thousands of concise reports describing the work. We sought publicity. On the seventeenth day of January, 1900, the dam at the south end of the channel was lowered and the waters of Lake Michigan began to flow southward. At that time, the Sanitary District had expended in creating the work over thirty-three million dollars. The water has been flowing through that channel for twelve long years without let or hindrance from any governmental source with the result that the typhoid death rate of the city of Chicago which in 1891 was 173.8 per 100,000 was in 1910, 13.26 per 100,000. Now you are asked to exercise your great power in restraint of this life giving flow; you are asked to rob humanity to enrich greed.

I am a part of the history of the Sanitary District; for fourteen years and two months, I was its chief engineer, the executive head of its construction, and I am and have been for nearly five years its consulting engineer and I know whereof I am speaking.

The opposition to the withdrawal of water for the uses of the Sanitary District come in great part from the shipping interests on the Great Lakes; the forefront of these is the Lake Carriers Association and of their opposition, I will now speak historically. This opposition first had an opportunity for official manifestation after the appointment of the International Waterways Commission in 1904 (?). I was first confronted by this opposition in June, 1906, when we were notified that a hearing would be given in Buffalo to all parties who wished to be heard in relation to the levels of the Great Lakes. This hearing took place on the 26th day of June, 1906, in the Federal building in Buffalo, and I was sent on to represent the Sanitary District of Chicago and defend its rights as best I could.

The meeting was a very depressing one to me, for I found myself friendless and in the enemy's country. The commission was unfriendly—when I say this I mean unfriendly officially, for in spite of our official differences I had personal friends on that commission, and I believe the official strike did not militate against personal kindness of feeling. The Canadian shipping interests were largely represented and were very hostile. Boston was upon its own dunghill and its opposition was bitter to the verge of brutality. The Lake Marine was there by its officers strongly arrayed against us.

The president of the Lake Carrier's Association, Mr. Livingstone, made an address which disconcerted me greatly. He said that the lowering of the lakes one inch meant to the modern lake carrier a loss of 100 tons carrying capacity and that the certain lowering of the lakes six inches meant a loss of 600 tons per trip, that the average number of trips per season was 22 and the average net earning 50 cents per ton. Then he gave the number of vessels that would be affected and showed an aggregate annual loss of $2,500,000. I came home much disheartened; but as I ruminated on the matter it occurred to me that there was no boat on the lakes that carried 100 tons per inch of draft. I got the Blue Book of American Commerce; scheduled all of the lake boats and computed their carrying capacity and was comforted.

Shortly thereafter the then Secretary of War, Mr. Taft, issued a notice that all who were interested in the question of lake levels would be accorded a hearing before him. Of course the Sanitary District took a hand in this. Its attorney and its chief engineer prepared arguments. I had all the data collected—to refute Mr. Livingtone's statements—in manuscript, but not knowing whether I would have a chance to use it I did not have it printed with the rest of my argument. The hearing was set for January 14, 1907. I went down a couple of days ahead of time to see if I could gather any new facts, that would help me. Through the help of our Congressman, James R. Mann, I secured an advance copy of the report of the International Waterways Commission, and therein—sure enough—was the Livingstone address without quotation marks and therefore adopted by the commission as its own. When my turn to address the secretary arrived I delivered my address as far as it was printed, and paused. The secretary addressed me thus: 'Mr. Randolph, have you seen the report of the International Waterways Commission?' I replied, 'Yes, Mr. Secretary, and I thank you for asking me that question, for it gives me an opportunity to call your attention to grievous misstatements in that report.' Then I read as follows:

'A Review of Some Questions Raised in the Report of the International Waterways Commission.'

On page 3, paragraph 24 of the report of the International Commission, I note a certain misleading statement into which the commission has doubtless been betrayed by the Lake Marine Interest, as I heard the assertion upon which it is based made to the commission in Buffalo on June 26th last by Mr.

Livingstone, president of the Lake Carriers Association. It is this:

'In the modern vessel each inch of increased draft adds about 100 tons to the carrying capacity.'

With this text they go on to state that:

'To lower the water surface six inches is to reduce the capacity of the vessel about 600 tons.'

Then they reason further:

'If the freight rate on ore be taken at 55 cents per ton, exclusive of the cost of loading and unloading, and the number of trips during the season at 22, there appears a loss of over $7,000 for the season for each vessel. The number of vessels navigating the Great Lakes which draw 19 feet or more is 417 and their tonnage is 1,514,414 tons, which is about three-quarters of the total tonnage of the lakes. It is a conservative estimate that the loss to navigation interests resulting from a reduction of six inches in the depth of water is $2,500,000 per annum, which capitalized at 4 per cent. amounts to a loss of $62,500,000.'

This is a terrific showing—but is it true. Here is the crux of the discussion.

I have made such a study as the sources of information available to me have admitted of and I find this:

The American Lake Marine comprises the following numbers of vessels of the several gross tonnages named:

265 vessels between 1 and 2 thousand tons.
158 vessels between 2 and 3 thousand tons.
77 vessels between 3 and 4 thousand tons.
99 vessels between 4 and 5 thousand tons.
31 vessels between 5 and 6 thousand tons.
22 vessels between 6 and 7 thousand tons.

652 vessels total.

At the time I heard President Livingstone make this statement, I accepted it as authoritative, but later upon reflection, I grew skeptical and so I began to investigate and give my results:

I found that in the American Lake Marine there were at the time he made this assertion 153 vessels, between 300 and 400 feet long. Maximum length in this class 396 ft. x 45 ft. That there were 111 vessels between 400 and 500 feet maximum length in this class of 488 ft. x 52 ft. beam. That there were 42 vessels between 500 and 600 ft. long and the maximum length of this class was 588 ft. x 58 ft. beam.

Of the maximum in each class there were:

1—396x45.

2—488x52.

6—580x58.

For the sake of argument, let us figure all of each class as of the maximum of that class—a manifestly improper thing to do—and see what results we get.

396x45 gives us 41.2 tons per inch of depth.

488x52 gives us 59.4 tons per inch of depth.

580 x58 gives us 78.8 tons per inch of depth.

153 vessels multiplied by 41.2 equals	7,303.6 tons.
111 vessels multiplied by 59.4 equals	6,593.4 tons.
42 vessels multiplied by 78.8 equals	3,309.6 tons.
	17,206.6 tons total

for 1 inch in depth. 17,206.6 multiplied by six, gives us 103,-239.6 tons for that depth. Multiply 102,239.6 by 22 trips and we get 2,271,271.2 tons as the year's loss of tonnage. This at 55 cents amounts to $1,249,199.16. Capitalize this sum at 4 per cent. and we get $31,229,979.00, instead of $62,500,000.00. Now let us try the inaccurate but approximately reasonable method of taking for these vessels an average between their maximums and minimum dimensions and see where we come out.

153 vessels 348x48 equal to 39.1 tons per inch,
or 5,982.3 tons.

111 vessels 444x48 equal to 47.3 tons each per inch,
or 5,250.3 tons.

42 vessels 540x56 equal to 70.8 tons each per inch,
or 2,973.6 tons.

14,206.2 total tons for one inch in depth.

14,206.2 multiplied by six (inches) equals 85,237.2 tons.

85,237.2 multiplied by 22 (trips) equals 1,875,218.4 tons, which, at 55 cents, amounts to $1,031,307.12, which sum capitalized at 4 per cent. amounts to $25,784,253.00 a considerable saving over $62,500,000.

It is proper before leaving this subject, to state that at least one vessel 600 feet long and 58 feet wide has been launched by the Chicago Ship Building Company and the same company is now building one 605 feet long x 60 feet. The tonnage per inch of depth of the first is 81.5 and of the second 85 tons. There is not a vessel in sight on the lakes having a carrying capacity of 100 tons per inch.

But why discuss any such proposition at all in view of the

report of a Board of Government Engineers that remedial works at the east end of Lake Erie will restore navigable depths at a cost of only $796,923.00; and when further it is demonstrable that a proper control of the waters of Lake Superior by works now installed, will remedy the whole evil? It may be urged that the existing works are inadequate, but it cannot be denied that they can be made adequate by a very inconsiderable additional expenditure.

As to the propriety of Canadian and U. S. Governmental advice to a city in any State of this Union as to the manner in which it shall dispose of its sewage and conduct its municipal engineering, I must leave the people of the several states to express their opinions.

ISHAM RANDOLPH.

Washington, D. C., Jan. 12, 1907.'

When I finished reading, the vice president of the Lake Carriers Association demanded that I withdraw the statement. I asked why I should. He replied, 'Because you are a civil engineer and don't know how to figure tonnage.' I asked how they figured it, and not one of them could tell me. I wrote out the formula, and giving it to General Ernst, who sat beside Mr. Taft, asked him if it was right. He examined it and said it was right. Then Harry D. Goulder, attorney for the Lake Carriers, came over and asked me to withdraw the report. I asked 'Why.' He said: 'Your sources of information are incorrect.' I showed him the book from which I got it. He said: 'That is authentic,' and sat down.

I have my copy of that report of the International Waterways Committee but it is a rare document. It was recalled and expurgated before re-issue.

Now the Chicago Sanitary and Ship Canal was built in conformity with the Illinois Sanitary District law passed in 1889, which requires that there shall be a dilution of 20,000 cubic feet per minute for every hundred thousand of the population draining into the channel. The work was predicated upon a population of three million and the flow required would therefore be 600,000 cubic feet per minute or 10,000 cubic feet per second.

What the view of prominent members of the United States Engineer Corps were in regard to this requirement is clearly shown by the following quotation from a report on a fourteen foot waterway from Chicago to St. Louis:

'The board does not condemn the present plan of taking 10,000 cubic feet per second, believing as it does that some

such amount will be needed to protect the lives and health of the people of a great city and of a populous valley, but it invites attention to the the fact that if a much larger amount be taken it will be necessary to construct remedial works elsewhere and that these are, or should be of an international character. It is led to make this remark by the attitude of the Illinois legislature and other principal advocates of this enterprise which is that a fourteen foot waterway is only a beginning and that a much deeper channel ultimately should be constructed, which means that a larger volume must be taken from Lake Michigan. It is the opinion of the board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case. It is possible to fix a limit to the future growth of Chicago. In a future not a remote larger amounts of water may be needed for sanitary purposes, and channels deeper than fourteen feet will then become practicable in the open alluvial portion of the Illinois river.'

The signers of this report were: O. H. Ernst, Coloniel Corps of Engineers; W. H. Bixby, Lieut. Col. Corps of Engineers (now General and Chief of Engineers); and Thomas L. Casey, Major Corps of Engineers.

From the report of the International Waterways Commission, dated December, 1906, I quote as follows:

'Any discussion of the preservation of Niagara Falls would have been incomplete without some reference to the Chicago Drainage canal, which was designed to divert from the southern end of Lake Michigan 10,000 cubic feet of water naturally tributary to the falls. A discussion of the effect of such diversion upon water levels, and consequently upon the navigation interests of the Great Lakes and of the St. Lawrence valley, could find no proper place in the Niagara Falls report. In recommending the allowance of 10,000 cubic feet per second to the Chicago Drainage canal the commission ignored those important questions. It is believed, in so doing, that it was accepting a general tacit agreement that some such amount was required to protect the health of Chicago, and that that city should have it without further question, whatever the effect upon navigation might be. It is believed also that the amount was all that Chicago asked or desired. It turns out that in this latter respect it was mistaken. Plans are on foot at Chicago which calls for a much larger amount at present and for amounts in the future to which no limit is assigned.

The commission has collected a large amount of information upon the subject and has held public hearings at Buffalo and Chicago, but its investigations are not entirely completed. It will at an early date submit a full report upon the subject.

(Signed) O. H. Ernst, *Chairman;*
George Clinton, *Member;*
E. E. Haskell, *Member.*'

There is so much that is pertinent and illuminating in the reports of the International Waterways Commission that I am tempted to quote therefrom in extenso but will resist that temptation and quote only a few passages. From their report transmitted Jan. 4, 1907, page 6, paragraph 19, I quote:

'In the expenditure of $40,000,000 for the drainage canal the people of Chicago, with its population of 2,000,000, incurred a burden equivalent to that due to an expenditure of $1,600,000,000 by the United States, with its population of 80,000,000—that is, enough to build eight or more Panama canals. It was a very serious effort and has commanded the admiration and sympathy of all observers. The diversion of 10,000 cubic feet per second from Lake Michigan affects other interests adversely, but these interests have withheld their opposition, seeming to believe that some such amount was necessary, and apparently willing to contribute their share to protect the lives and health of the people of a great city. The plans calling for that amount have been under public discussion for some years. Although withholding formal approval, the Federal authorities have taken no steps to prevent their execution. Congress has called for a plan and estimates for an improvement of the waterways connecting with it, the scope of which is fixed by that amount. There appears to be a tacit general agreement that Chicago needs or will need about 10,000 cubic feet of water per second for sanitary purposes and that the city should have it without further question.'

From the same report, page 15, (r) and (s) of the summary:

'(r) The diversion of 10,000 cubic feet of water per second at Chicago will render practicable a waterway to the Mississippi River fourteen feet deep. Any greater depth must be obtained by the abstraction of more water from Lake Michigan and at the expense of the navigation interests of the Great Lakes and of the St. Lawrence valley.

(s) The effect upon Niagara Falls of diverting water at Chicago is of secondary importance when considering the

health of a great city and the navigation interests of the Great Lakes and of the St. Lawrence valley, but it is proper to note that the volume of the falls will be diminished by the full amount diverted at Chicago.'

And paragraph 43 on page 16:

'A careful consideration of all the circumstances lead us to the conclusion that the diversion of 10,000 cubic feet per second through the Chicago river will, with proper treatment of the sewerage from areas now sparsely occupied, provide for all the population which will ever be tributary to that river, and that the amount named will therefore suffice for the sanitary purposes of the city for all time. Incidentally it will provide for the largest navigable waterway from Lake Michigan to the Mississippi river which has been considered by Congress.

We therefore recommend that the Government of the United States prohibit the diversion of more than 10,000 cubic feet per second for the Chicago Drainage canal.

All of which is respectfully submitted.

(Signed) O. H. Ernst,
Brigadier-General, U. S. Army, retired; Chairman American Section.

George Clinton,
E. E. Haskell,
Members American Section.
Geo. C. Gibbons,
Chairman Canadian Section.
W. F. King,
Louis Coste,
Members Canadian Section.

Attest:

W. Edward Wilson,
Secretary American Section.
Thomas Cote,
Secretary Canadian Section.'

From Report, dated December 1, 1907, Appendix C, page 17, letter addressed to Secretary of War:

'The situation is fairly stated by the company, and the request seems to us reasonable. It is consistent with the recommendations contained in our report of March 19, 1906, which reads as follows, viz.:

"If the falls are to be preserved it must be by mutual agreement between the two countries. As a step in that di-

rection we recommend that legislation be enacted which shall contain the following provisions, viz.:

(a) The Secretary of War to be authorized to grant permits for the diversion of 28,500 cubic feet per second, and no more, from the waters naturally tributary to Niagara Falls distributed as follows:

	Cu. ft.
Niagara Falls Hydraulic Power & Manufacturing Co...	9,500
Niagara Falls Power Company........................	8,600
Erie Canal or its tenant (in addition to lock service)...	400
Chicago Drainage canal	10,000

(Signed) O. H. Ernst,
Brigadier-General, U. S. Army, retired, Chairman;
George Clinton, *Member;*
E. E. Haskell, *Member.*'"

It is proper to state here that the preceding part of this brief was prepared prior to my leaving Chicago on March 25th, to attend the hearing which you accorded to the Dominion of Canada and its shipping interests two days later. At that time I had no knowledge of what transpired before you on Feb. 28, last. As I journed to Washington, I had an opportunity to read a stenographic report of that hearing which informed me of certain erroneous and surprising statements made then, which in the interest of truth and in behalf of the State of Illinois, I must take notice of.

The hearing which you held on the 27th instant was also fruitful of assertions which I must refute if I can and I believe I can.

Carrying Capacity of Vessels.

First, I will deal with the claims made for capacities for lake steamers, which are palpably in error. I had hoped that the outcome of the hearing on Jan. 14, 1907, a certain phase of which I have hereinbefore recited, had put that question beyond the point of argument, but my hope is disappointed. The carrying capacity of any maritime craft is gauged by the amount of water which she displaces. Each cubic foot of fresh water weighs 61½ lbs. I will make my illustration fit the lake carriers, with which this whole discussion arose.

The class of boat doing business on the Great Lakes is adopted for its utility and not its 'symmetry of mould'; it approaches very closely to the lines of a monster watering through; its horizontal section, save for the taper at stem and

stern—to make it ship-shape—is a parallelogram. To get at the area of this horizontal section, we multiply the length by the breadth and then take nine-tenths of the result as the approximately true area. Having the area and desiring to know the displacement each inch of depth, we multiply the area by 62½, divide by 12 (to get the weight per inch) and then divide the result by 2,000 lbs. The quotient will be the number of tons that the vessel will carry per inch of depth. An approximately accurate formula is:

Length a x breadth b divided by 42.7.

Revised Statute, Section 4150, of Navigation Laws, lays down clearly the rules for determining length, depth and width for computing tonnage. There is no vessel afloat on the Great Lakes that carries in excess of 82.2 tons per inch. I read on page 380 of the stenographic report of the hearing before you this statement from Mr. William Livingstone, president of the Lake Carriers Association: 'We figure our modern boat, that our 600 footers, that we average 113 tons per inch.' I trust that this is a stenographic error, for I heard Mr. Livingstone testify, under oath, on May 24, 1909, that the capacity of such boats was 80 tons per inch. This question is of importance because of the effort to show enormous losses to the shipping interests by reason of lowering the lakes. I considered it so important that I have figured out the tonnage capacity per inch of every American vessel of 400 feet length, or over, on the Great Lakes; and as an appendix hereto I submit a schedule giving all of these boats, with their tonnage, length and width as defined by statute and with the names of their owners. With this schedule I submit drawings of the lake carrier J. K. Sheadle, built in 1906, that you may see how to apply the statutory rules for determining dimensions. The data for the schedule submitted is offered by the Blue Book of American Commerce for 1910, a compilation for which Mr. Eugene T. Chamberlain, Chief of the Bureau of Navigation, Department of Commerce and Labor, is responsible.

The Hydrographs of the Great Lakes.

Mr. Secretary you are looking for the truth in regard to this controversy. You must found your ruling upon the bed rock of truth, or else that ruling will be like the house founded upon the sand; when the rain of criticism descends and the winds of opposition blow and the floods of indignation come

the decision will fall 'and great will be the fall of it.' Is not your confidence in the integrity of the U. S. Engineer Corps sufficient for you to accept their exhibit of recorded facts? Are they not men who will not lie? I am willing to rest the case of the State of Illinois on their facts—not on their opinions—I tie to their facts and many times I dissent from their opinions.

I submit herewith a hydrograph prepared by the 'United States Lake Survey' showing 'Monthly mean water levels of the Great Lakes from Official Records of 1860 to Date.'

To examine that exhibit, start in with Lake Superior, the level of which is about 22 feet above Lake Huron, into which it empties and it is, therefore, above and beyond the influence of the draft made upon the lakes by the Sanitary District of Chicago.

Note that its low water period came in 1892-3 and that it afterwards rose and kept well above the low water mark until April, 1911, when it fell 4½ tenths below the lowest previous water, but recovered and rose 1.65 feet. Now drop down to Lake Michigan and note its lowest water December, 1895, four years before the Chicago Sanitary Canal was opened. Note how it rose after that period and never has gotten as low since, although it showed a drop responsive to the reduced out-flow of Lake Superior, in 1911. Now note Lake Huron conditions, which are practically synchronous with those of Lake Michigan.

Now drop down about 8 feet to the surface of Lake Erie and note its lowest stage in November, 1895, a stage which it fell below by half a tenth of a foot, in February, 1902, but ever since then it has been well above that low water mark. Now drop down about 327 feet to the level of Lake Ontario and note its low water in November, 1895, and then see that ever since the opening of the Sanitary District the lowest stage reached by that lake has been nine-tenths of a foot above the low water of 1895, and that the lowest stage reached in 1911 was one foot and one-tenth above the low stage of 1895.

Mr. Secretary, weigh well this showing made by the loyal men of your own department, and then believe contrary showings from sources less well authenticated if you can. This brings me up to a discussion of arguments advanced by your honored Chief of Engineers, General William H. Bixby. My association with him, usually in opposition, extends over a number of years. We have been frank with each other and as he once expressed it to me 'we have played the game with

our hands on top of the table.' On Jan. 8th last I received a letter from him enclosing a copy of a letter which he had given to 'a few members of Congress.' The closing sentence of this letter reads, 'Moreover none of these copies was distributed until after I had shown you personally the blue prints and told you about them, as I considered that you especially were entitled to early notice of their interests.'

I will address myself now to the closing sentence of his enclosure to me. 'The end of 1912 will probably see these four lakes lower than in 1895-1896 (the lowest yet known since 1860) and more than 1.5 feet lower than their average of the past 51 years.'

Now I want to call your attention to what I consider a serious omission on the General's part when he promulgated his conclusions. He did not permit himself to consider the causes of lowering in the 13 years preceding 1900.

If you will consult Document No. 159, Fifty-sixth Congress, Second Session (a report prepared by Lieut. Col. J. W. Raymond, Mr. George Y. Wisner and Mr. Alfred Noble on Deep Waterways between the Great Lakes and the Atlantic) you will find this statement on pages 297-298: 'The low water level of Lakes Michigan and Huron has been lowered about 1 foot during the past 13 years by natural and artificial deepening of the St. Clair and Detroit Rivers.' That, mark you, was before one drop of Lake Michigan water had trickled into the Chicago Drainage canal. There is one foot of the 1.5 for which General Bixby contends, accounted for without making Chicago accessory to the recession. I shall take up this particular phase of the discussion again under the head of interlake channels.

Opposition to Granting the Permit Sought in the Sanitary District.

In taking up a discussion of the objections to the granting of the permit sought, I feel that I have to deal with honest conviction on the part of many of the objectors that the fears which they express are founded upon what they believe to be facts. In the front rank of this honorable class stands the Dominion of Canada, so ably represented by Hon. David Mullin, K. C. There is other opposition which is factious and still other which is purely selfish and which endeavors to mislead you by specious and fallacious allegations. It is not incumbent upon me to differentiate between these classes of ob-

jectors and to distinguish them by name. I think, however, that before I finish this discussion you will know who I think they are. although I name no names.

Dominion of Canada, Represented by Hon. David Mullin, K. C.

In conversation between this gentleman and Mr. J. C. Williams, counsel for the Sanitary District of Chicago, to which I was a party, Mr. Mullin said that he had been called suddenly in this case and had had scant time for preparing his discussion of it. This acounts largely for his use of so-called facts which he had no chance to verify, and I am sure he would not like to be held responsible for their accuracy. On page 4 (typewritten brief) he asserts that there has been no acquiescence by Canada in the granting to Chicago of 10,000 cubic feet per second. I have hereinbefore quoted at some length, from the reports of the International Waterways Commission. These reports are public documents submitted contemporaneously to both the United States and Canada. They were in the nature of information and advice to each Government, concurred in by the joint advisers. There is in this case something stronger than the old doctrine of consent given by silence. These great powers were informed and advised and no dissent came from either. If in their wisdom they thought the Sanitary District ought to be restrained, it was their duty to take action and save that District the cost of outlays they were prepared to make. Their joint servants received no instructions to protest against the taking of this water by the Sanitary District, and, assured by their silence, that District has gone on spending millions of money, raised by taxation, in perfecting its system along the lines of the original project. He takes up the question of water power and through misinformation states that the Sanitary District development at Lockport is 56,000 H. P., so I will go at some length into that question.

I do not think he quite appreciates the absurd conclusion he ascribes to the International Waterways Commission when he quotes from their reports of January 4, 1907 (see page 24), to the effect that 800 c. f. s. to be taken from the Calumet river and 300 c. f. s. taken from the Chicago river will be added to the 10,000 c. f. s. sought to be taken from Lake Michigan, thus making the total outflow '11,000' c. f. s. This water is measured at he discharge end of the canal and every cubic foot coming from any other source than the lake reduces the

direct abstraction from the lake. Hence, under his theory, using the terms he gives, only 8,900 c. f. s. would come from the lake reservoir direct.

In the matter of carrying capacity of lake vessels he falls into the same trap that so embarrassed the International Waterways Commission in 1907. Some president of a marine association must have told him that these vessels carry 110 tons to the inch of draft. Either this or the figures are based on the starved ton that coal dealers sometimes send to their retail customers.

On page 17 he takes up the traffic at Sault Ste. Marie and shows again that somebody has given him wrong information. I have with me a "Statistical Report of Commerce Passing Through Canals at Sault Ste. Marie, Michigan and Ontario, During Season of 1910, Prepared under Direction of Col. C. McD. Townsend, Corps of Engineers U. S. Army."

Let us contrast Mr. Mullin's statement with Col. Townsend's report. First, Mr. Mullin, "The Canadian Canal 31,-531,036 tons and the American Canal carried 15,602,673 tons." Col. Townsend reports American Canal 25,927,661 tons, Canadian 36,435,557 tons. American per cent. 42, Canadian, 58. American Canal open 224 days. Canadian Canal open 248 days. This difference in time opening for traffic is not explained, but the deduction is that the Canadian Canal carried 10,507,896 tons more freight than the American Canal and was in commission for 24 days longer than the American Canal, or reduced to percentages 16 per cent. more freight or 10½ per cent. more time. It seems certain that the longer navigation period through the Canadian lock had more to do with its larger usefulness than did its four inches greater depth over the miter sill.

On page 27 he has something to say about the water supply and sewage disposal of Toronto. Here his misinformation is second-hand. Toronto does filter its water supply. It is discharging raw sewage into its harbor; it proposes, unless its authorities have changed their plans since receiving the report of its water supply commission—of which I am a member—to discharge its raw sewage after removing a small percentage of coarser solids by screening, directly into Lake Ontario, without treatment. Constant reference is made to the reports of the International Waterways Commission.

Mr. Secretary, I urge you to get that full set of reports and read them carefully. Of course, Mr. Secretary, I do not presume to argue the propostions of law put up to you by the

learned King's Counsel. My knowledge of law is only that absorbed by thirty odd years of contaminating association with learned lawyers.

Among those who came to support Mr. Mullin's contention was Mr. R. W. Reford, president Montreal Board of Trade. On page 184 I read this statement made by him: 'The principle upon which application for further diversion of water is made is unsound and if conceded further demands from other municipalities may be such that to grant them would destroy navigation in a commercial sense.' The Maker of the Universe has so constructed the region around the Great Lakes that there is but one locality along the shore line of these 'unsalted seas' where water can be made to flow by gravity from one water shed into another water shed, and Chicago occupies that strategic position; hence there can be no ground for Mr. Reford's fears 'that other municipalities will make' menacing demands. Next came Mr. Allen, president Shipping Federation of Canada, owners of two ships, the 'Victorian' and the 'Virginia.' He says 'we send these ships out at drafts ranging from 27 feet 5½ inches to 26 feet and they went out in six trips with a vacancy of 8,340 tons and 27 feet 6 inch draft, the ships drawing 26 feet 6 inches.' This language needs interpretation for my understanding in view of what he says in the previous page (190) 'we get down to 29 feet, not 27 feet, as stated by Mr. Meredith.' Now if they had 29 feet of water, why did they load to only 26 feet 6 inches when they claim to load to the last inch of draft? Mr. Francis King, representing the Richelieu and Ontario Navigation Company (page 158) sets up a plea for certain excursion boats which 'shoot the chutes' at various rapids, much to the enjoyment of sensation-loving excursionists. I do not know whether Mr. King lays most stress on the thrills which run down the back-bones of the excursionists, or the earnings of the boat owners; but Mr. Secretary, I ask you if you will weigh those thrills against the pangs of fever-stricken Chicagoans, or the losses in those two boats against the loss of investment made by the people who, to save their lives, have put $65,000,000 into the Chicago Drainage canal. I want to set down to Mr. King's credit that where he gives the tonnage of boats that he lists, he has not followed Lake Carrier precedents.

Now as to the claims of lessened harbor depths at Toronto. Look at your hydrographs of Lake Ontario and decide on the credibility of the witnesses. It cannot help you there but I

believe the U. S. Engineers. And what I advise about Toronto, I advise about Milwaukee, Toledo, Cleveland and all of the lake cities and towns which have protested against issuing this permit, because of the lessened depth in their harbors. Now there is in Mr. Mullin's brief, on page 13, a table giving what it is now the actual lowering, what they think it will be with an abstraction of 10,000 cubic feet per second and what they thought it would be for 14,000 cubic feet per second. They say they know what it is under conditions of flow as they have existed and as they do exist.

Now every officers of the Corps of U. S. Engineers who has been stationed in Chicago for ten years past knows that the flow through the Chicago river has greatly exceeded the volume named in the permit of the Secretary of War. Prior to the opening of the power plant at Lockport the whole flow passed through the controlling works and by their measurements, constantly noted and recorded, we kept a reliable record of the flow. That information is among the records of the Sanitary District. Since the opening of the power plant, in the fall of 1907, the question of discharge has been more complicated and the records less reliable. Two years ago, in trying to arrive at the natural low water flow of the Illinois river, I had to determine the flow in the Sanitary canal, which I did by meter measurements taken at Romeo. I found the flow to be slightly in excess of 7,000 cubic feet per second. These gentlemen have assumed a state of facts which do not exist and they find an actual lowering of four and three-tenths inches at Montreal. Note the three-tenths inch—very accurate work that. In view of their lack of dependable knowledge, what reliance can you place upon their determinations for 4,166 cubic feet per second or 10,000 cubic feet per second, or 14,000 cubic feet per second? How great is your faith?

The Water Power.

It has been directly charged that the motive back of this request for a larger flow of water is that the increased flow may develop water power.

This has become a hoary charge which I have had to meet before Congressional committees and otherwise.

I was employed by the Sanitary District of Chicago on June 7, 1893, to build its drainage canal—that and nothing more.

At first the construction problems absorbed my thought and my activities. As by organization and training the work

itself ceased to demand my exclusive thought, I came to realize that some day there would be a man-made river rushing down the declivity from Lockport to Joliet and that a great potentiality would be running to waste which ought to be conserved for the benefit of the people, whose taxes had paid for the great work. I outlined a plan for this conservation and submitted it to the Board of Trustees, with the result that I was set down upon and told that I was employed to build a drainage canal, not to look after water power. I was sat down upon, but my upholstering is not of the kind that makes sitting a luxury for the sitter and I persisted in my purpose of having that water utilized and the power works at Lockport are today a monument to that persistency.

Now the cost of building that channel from Robey street, Chicago, to the controlling works was $33,000,000. The cost of giving the Chicago River dimensions adequate for the flow of 480,000 cubic feet per minute (8,000 cubic feet per second) has been $11,000,000. The pumping plant and the 39th st. conduit for the delivery of 120,000 cubic feet per minute (2,000 cubic feet per second) to make up the total of 600,000 cubic feet per minute required to dilute the sewage of 3,000,000 people has cost approximately $2,000,000, or a total of $46,000,000, without the slightest provision for water power. Now the dependable fall at the Lockport power site is 34 feet. A flow of 10,000 cubic feet per second falling 34 feet will yield 30,900 horse power on an efficiency of 80 per cent. Now to get this water to the controlling works cost $46,000,000, or $1,488.67 per horse power. The interest on this cost, at 5 per cent., is $74.43 per annum. The net earnings per horse power will not exceed $25 per annum. Do business men make those kinds of investment? To utilize this power, three more miles of channel had to be built and the power plant erected, which was done at a cost of approximating $4,500,000.

I was before the Rivers and Harbors Committee of Congress in regard to the Calumet-Sag channel, which the district desired to build to reverse the flow of the Calumet River, just as the Chicago River had been reversed. I was asking for 4,000 cubic feet per second, my estimates on the cost of such a channel were nearly $12,500,000. I was asked by a member of the committee if my real purpose in seeking to get this water was not to create water power with it? My answer was in the form of a demonstration of the value of the power set over against the cost. Horse power to be obtaine 12,360 net, cost $12,500,000; cost per horse power

$1,011.32. The answer conclusively removed the mercenary motive from my plea.

Now this all pertains to the Sanitary District, a creation of and therefore subordinate to the State of Illinois, which I represent in this controversy. The water—which is so necessary to the health and life of Chicago, is flowing past the wheels at Lockport and dropping in the next 62 miles 100 feet. One hundred feet of fall 10,000 cubic feet of water per second; after deducting 12 feet for necessary slope there remains 88 feet of head, 10,000 feet of water with a net potentiality of 80,000 horse power. The Sanitary and Ship Canal of Chicago was not created for gain, but for health and life, and incidentally commercial navigation. As a natural consequence of this great construction a great potentiality is running to waste down the Illinois River. Does not true conversation demand that it be used for the service of man?

Mr. Mullin, in his able presentation of the cause of the Dominion stated that this water would produce four times more power if flowing through the interlake channels and the St. Lawrence, than it would at Lockport. He had knowledge of the creation at Lockport only and not of the potentialities that lied down stream from it.

With all the vast possibilities of power between the head of the Niagara River and Lake St. Peter now available and unavailed of, I would ask Mr. Mullin if his opposition to the use of about 4½ per cent. of these potentialities by Illinois does not savor of selfishness, does not even suggest the dog in the manger, a position which I am sure he would not unwillingly occupy, either for himself or his people.

On page 75, chapter 16 of the report of the preservation of Niagara Falls which the President transmitted to Congress Aug. 21, 1911, the following statement is found:

A volume of 210,000 with a descent between the dead line and the upper gorge of 220 feet has a potential of over 5,000,000 horse power.

Now the drop from Lake Erie to Lake Ontario is, roundly stated, 327 feet, so that there is 107 feet not accounted for in this statement, I assume that 92 feet of the 107 feet may be useful head and on that assumption I find, using an efficiency of 80 per cent., upwards of 1,700,000 horse power running to waste or a total potentiality for 210,000 cubic feet per second of water dropping from Lake Erie into Lake Ontario of over 6,700,000 horse power. Of the other millions of horse power going to waste in the drop from Lake Ontario to Lake St. Peter, no mention is made.

Conditions at Montreal.

We have had a luminous illustration flashed upon us by our Canadian friends of the embarrassment which may result from discussing grave questions without having a basis of authenticated facts to sustain our position.

My knowledge of conditions in the Montreal harbor is meagre, gleaned from the Encyclopedia Britanica, Reports Nos. 100 and 110 of the U. S. Hydrographic Office and from maps studied in the Congressional library. As the results of these studies I have formed conclusions, not rock ribbed, but tentative. First, the ascertaining of the velocity of streams is a determination involving cross section, slope, roughness of channel and some judgment must be exercised in selecting the coefficients used in the computations. But with the velocity once known and the average width of the stream the depth due to any given volume of flow is easily ascertained with approximate reliability. Knowing the velocity in feet per second and the width of the stream, multiply the one by the other and divide the volume of flow per second by the result of the multiplication. The result thus found will be the depth due to that volume of water flowing with the known velocity.

The Encyclopedia tells us that the St. Lawrence Channel below Montreal permits ocean vessels drawing 30 feet at low water to reach the city docks. That after the river freezes over there is a local rise of 10 feet.

A map entitled 'Montreal Harbor from Latest Canadian Charts,' scale 1/12.000 published at Admirality, 8th of July, 1908.

Data on this Map.

River dredged to 30 feet below the low water of 1897. The width dredged is 450 feet with greater width at all curves. The river has a very great fluctuation and is usually at its highest in the second week of May and at it lowest from about the middle of September to the end of November. Its average height above datum of soundings is: In May, 8 feet; June, 6 feet; July, 5¼ feet; August, 3¼ feet; September, 2¼ feet; October, 1¾ feet; November, 2¼ feet. The rise in level from Longue Point to Lachine Canal is 1.74 feet.

I scaled on this map the width opposite La Salle avenue, which seemed to be about an average width and found it 4,650 feet from city shore line to sand shoals opposite.

U. S. Hydrographic Report 100, gives datum as extreme low water of 1897 which was 13 feet and 7 inches on the old lock sill of the Lachine Canal at Montreal and it is 1½ feet below ordinary low water.

This is seemingly reliable data, but without knowing velocities no deduction could be made. This information was furnished by another Admirality map on which velocities are shown at certain points. These velocities are in knots per hour (Kn):

Just below Victoria Bridge 8 Kn.

Opposite DeLarimer av. 6½ Kn.

Opposite Montreal st. railway 5½ Kn.

Now a nautical mile or knot is 2,029 yards or 6,087 feet, hence 5½ Kn equal 334,785 feet per hour, or 9.3 feet per second.

By the approximate rule that I have given, used with the data available, I get 4,650 feet by 9.3 seconds gives 43,245 cubic feet; 10,000 cubic feet per second divided by 43,245 gives a depth of 23/100 of a foot. Conditions at Montreal are very much complicated by the inflow from the Ottawa River a few miles above the city.

The Bixby Report on Illinois Waterway.

Mr. Mullin, K. C., representing the Dominion of Canada, quoted with approbation a statement which appears in the report of a board of engineers, of which General Bixby was chairman, in which they state that 1,000 cubic feet per second was sufficient for all of the needs of navigation. This report wronged the interests and the rights of the State of Illinois so greatly that I asked for a hearing on it before Mr. William H. Taft, President of the United States. This request was granted and on April 13, 1911, General Bixby joined me and we argued the questions at issue before the President. As a result of that discussion the President wrote Governor Deneen the following letter:

The White House,
Washington, April 17, 1911.

Hon. Charles S. Deneen, Governor of Illinois:

Sir—I have your communication of April 15, 1911, under advisement. The project for a navigable waterway from Lake Michigan to the mouth of the Illinois River, and thence via the Mississippi to the Gulf of Mexico, is one of national importance and commands my sympathy.

In view of the work already accomplished by the Sanitary

District of Chicago, an agency of your State, which has constructed the most difficult and costly stretch of this waterway and made it an asset of the nation; and in view of the fact that the people of Illinois have authorized the expenditure of $20,000,000.00 to carry this waterwav sixty-two (62) miles further to Utica, I feel that it is fitting that this work should be supplemented by the Government and that the expenditures recommended by the Special Board of Engineers on the waterway from Utica to the mouth of the Illinois River be made upon lines which, while providing a waterway for the nation, should otherwise benefit the State to the fullest extent.

On behalf of your State, there has been no legislative commission with whom the Board of Engineers could negotiate and the board has reported a project for the lower river which, I learn from your letter, is not satisfactory to the State.

In view of this fact, I shall recommend to Congress that the term of service of said board be continued and that it be empowered to re-open the question of the treatment of the lower Illinois River, and to negotiate with a commission hereafter to be created by your General Assembly, and to agree with such commission upon a plan for the improvement of the lower Illinois River and upon the extent to which the United States may properly co-operate with the State of Illinois in securing the construction of a navigable waterway from Lockport to the mouth of the Illinois River in conjunction with the development of water power by the State between Lockport and Utica.

Very truly yours,

Wm. H. Taft.

In conformity with the statement in that letter, the President did, on December 21, 1911, transmit to Congress a message containing this language:

The project for navigable waterway from Lake Michigan to the mouth of the Illinois River, and thence via the Mississippi to the Gulf of Mexico, is one of national importance. In view of the work already accomplished by the Sanitary District of Chicago, an agency of the State of Illinois, which has constructed the most difficult and costly stretch of this waterway and made it an asset of the nation, and in view of the fact that the people of Illinois have authorized the expenditure of $20,000,000.00 to carry this waterway 62 miles farther to Utica, I feel that it is fitting that this work should be supplemented by the government, and that the expenditures

recommended by the special board of engineers on the waterway from Utica to the mouth of the Illinois River be made upon lines which while providing a waterway for the nation should otherwise benefit that State to the fullest extent. I recommend that the term of service of said special board of engineers be continued and that it be empowered to reopen the question of the treatment of the lower Illinois River, and to negotiate with a properly constituted commission representing the State of Illinois, and to agree upon a plan for the improvement of the lower Illinois River and upon the extent to which the United States may properly co-operate with the State of Illinois in securing the construction of a navigable waterway from Lockport to the mouth of the Illinois River in conjunction with the development of water power by that State between Lockport and Utica.

This brings us up to the importance of—

The Lakes to the Gulf Deep Waterway.

The need of this waterway has been felt for generations and its inception goes back to the early days of the Nineteenth Century, when it was so strongly advocated by Albert Gallatin. Chicago has built the most costly link in this waterway and the whole Mississippi Valley is interested in its completion. Its need is great now and that need will be vastly accentuated after the opening of the Panama Canal.

The President evidenced his interest in this project when he sent the following letter to the chairman of the Rivers and Harbors Committee of Congress:

The White House,
Washington, D. C., Dec. 23, 1911.

Hon. S. M. Sparkham, Chairman, Rivers and Harbors Committee:

Sir—In view of the great importance to the whole country of the creation of a waterway from the Great Lakes to the Gulf of Mexico, I call your attention briefly to a consideration not taken up in the section of my message which related to that waterway. The State of Illinois has, by an overwhelming vote of the people, authorized the expenditure of $20,000,000.00 for building of that link in this waterway between the present terminus of the Chicago Sanitary canal—near Lockport—and Utica on the Illinois River, a distance of sixty-two miles. The opponents of the project have questioned the suf-

ficiency of the amount—authorized by the people of the State—to pay for the work planned by the Internal Improvement Commission of the State. These estimates, however, have been checked by the board of engineers, whose appointment was authorized by the Sixty-first Congress, Second Session, and were by them considered sufficient to cover the cost involved. See H. R. Document No. 1374, pages eight and ten. On page eleven, this statement is found.

'Should the State of Illinois be unable to complete the locks suggested by the board, or the bridges required by navigation, the United States might then properly undertake to complete these parts of the project, but as the authorized appropriation of $20,000,000.00 by the State is considered sufficient for all work above Utica, no estimates are submitted for these parts.'

I concur in the belief of the board as expressed above and feel that the Congress should endorse the project; and further in view of the character and ability of the men who have reported upon the project, I think that the United States runs small risks in guaranteeing any sum that this link in the project may cost in excess of the $20,000,000.00 that the State will provide. This work should progress in time with the improvement of the upper Mississippi, the Missouri and the Ohio rivers. Its importance warrants congressional action in its support.

(Signed) WILLIAM H. TAFT,
President.'

Now there can be no higher use of a natural resource than the saving of human life. Quotations made hereinbefore show how the water that is being abstracted from Lake Michigan is fulfilling the highest mission of saving life, and when you consider that it will at the same time serve to make a commercial waterway, you see how justly we can demand it, both in the name of humanity and of navigation. Canada has an outlet to the sea from the Great Lakes by a 14 foot channel. Should America have less to her southern sea? And be it remembered that this waterway will, when built, be a free channel, free to Canada, free to the world. Canada will need to reach southern ports by the short water route, just as will the citizens of the United States, who dwell in our lake ports.

Mr. James White, secretary Commission of Conservation, opposes the taking of this water for both economic and scenic reasons. Let us first consider the economic side of it. The

volume of water involved in this present controversy is 4 76/100 per cent. of the flow through the St. Clair River with the Lake Huron elevation 581.28 and 4 54/100 per cent. of the flow of the Niagara River. What will this abstraction accomplish? It conserves the life and health of the second greatest city in America. The typhoid death rate of that city in 1910 was 13 26/100 per 100,000; in 1891 it was 173 8/10. It makes a 14 foot navigation from the Great Lakes to the Gulf possible; it will afford 110,000 net electrical horse power. It makes the Illinois River, next to the Columbia River, the greatest producer of food fishes in America. Is not this true conservation? Can it be shown that 10,000 cubic feet of water used anywhere else in the world will do mankind as much good? When we contemplate the aesthetic side of it, our gaze concentrates at Niagara. The beauty and grandeur of that wonderful work of the Great Creator can be preserved by simple engineering construction. I laid a plan for this before the Minister of Public Work of the Dominion of Canada Feb. 13, 1911.

Dr. Pugsley referred this project to Messrs. St. Laurent and Coste with whom I conferred. Their expressed views to me were approving. When I presented my letter of introduction from Mr. Taft to Mr. Fielding, Minister of Finance, his first inquiry was, is there any money in it for Canada? He then said, 'We have to look at these things from the dollars and cents standpoint.'

I told him that the beauty of the Falls could be maintained and at the same time a larger use of water be granted for generation of power.

Confirming this assertion—although it has no reference to the project which I brought forward—I call attention to the fact that on August 21, 1911, the President transmitted to the Senate and House of Representatives a message giving 'Information relative to scientific investigations made by certain officers of the War Department for the preservation of Niagara Falls.'

In Chapter XVI, page 75 et seq., their conclusions are summed up. I quote therefrom:

Provided there be no large increase in up-lake diversions, the possibilities of continued and extended use of power at the Falls are conditioned upon the construction of regulating works in the Niagara River to avoid the wasteful outflow of water of Lake Erie. The injury to the scenic grandeur of the Falls, and the intereference with the navigable waters of the

Niagara River and Lake Erie, due to up-lake diversions would be largely obviated by impounding in the lakes a portion of the winter out-flow during the months of December to April, inclusive, enough water may be saved to hold the lakes in a proper and economical level to the betterment of navigation, and yield a surplusage to practically offset diversions at the Falls. This is a practical engineering proposition but as the power companies are beneficiaries they should pay a fair share of the cost.

Here, all that—we as State and Sanitary District officials—have contended for through long years of controversy is admitted as being right in theory and capable of practical development.

Mr. White (I think it was he, I have not his brief to refer to) brought up the question of extravagant use of water by the District for purposes or dilution. If ever there was a long contested question this has been one. Let him scan the 8,000 printed pages of testimony in the case of the State of Missouri vs. The Sanitary District of Chicago and see if he can discover a scientific authority on either side of that great controversy who would admit that 20,000 cubic feet of water per minute was too much to use in diluting the sewage of 100,000 people. It is the habit of both sides of this controversy to appeal to the printed reports of the International Waterways Commission—and it is a good habit too—Mr. White has it. Now that commission employed sanitary experts to advise them; the best men they could find. These gentlemen stated as their second conclusion—

The latest conclusions of sanitary engineers as to the amount of dilution which is required to make sewage inoffensive are that a dilution of 3⅓ cubic feet per second for each 1,000 persons connected with the sewers as provided in the enactment of the Illinois Legislature of 1889, is as low a figure as it is now possible to state.

Page 51 of report dated Toronto, Ontario, January 4, 1907.

What was, after patient inventigation, determined upon was found to stand the test of 18 years of progressive science.

Objections from the State of Michigan.

Objections from a sovereign state must receive consideration and respect, but it is very hard to treat seriously the plea upon which the objections from Michigan are based. They are in the same super-sensitive category with the charge

raised some years ago that the cold water sent down the Mississippi River by the Chicago Canal was destroying the strawberry crop in Mississippi and Louisiana. In my study of these lake level problems in preparation for these ever recurring controversies, I ascertained as nearly as may be that the state of facts is very nearly as follows:

The discharge through the St. Mary's River is ordinarily 75,000 cubic feet per second. At the time I made my computations the reported flow through the St. Clair River was 206,400 cubic feet per second: 131,400 cubic feet of which must come from Lakes Huron and Michigan. Figured on the ratios of rainfall and area I find that Lake Michigan contributes 48.26 per cent (63.414 c.f.s.) and Lake Huron 51.74 per cent. (67,986 c.f.s.).

Now if Chicago takes 10,000 c.f.s. it leaves the outflow from Lake Michigan through the Straights of Mackinac 53,414 c.f.s. and the changed flow cannot, in my judgment, have an appreciable, or any effect upon the climate of Michigan. However, Congress has imposed upon a Commission of Engineers the duty of determining and reporting to it the climatic changes brought about in Michigan by the work of the Sanitary District. If you mean to wait for the determination of this question until those engineers report, we pray you to spur their action; for they are under your jurisdiction.

Objections from the Illinois Valley.

Sundry objections to granting the plea of the Sanitary District of Chicago until such time as the channel of the Illinois River has been made adequate to carry the flow artificially delivered to it, have been filed by associations and individuals living and owning property in the Illinois Valley. We have no quarrel with these petitioners, in fact there is a basis of reason in their effort to protect themselves through you. They are suffering a burden which they ought not to bear.

The Sanitary District of Chicago is required by its organic act to remove from the Illinois River the dams at Henry and at Copperas Creek. They have never done it and they have never done it because they have bene enjoined from doing it by a court of competent jurisdiction on the petition of the canal commissioners of the State of Illinois. You need not be burdened by the details of this family row. The dams ought to be removed—they are not needed for navigation—as is reported by a board of engineers of the U. S. Engineer

Corps, and they are a positive harm to the low lands along the river by holding the water at high and harmful elevations. These elevations are not great, but they are harmful.

Now, Mr. Secretary, do you feel called upon to punish one side or aid the other to this controversy? With these dams removed there would be peace in our camp and if you can see your way to their removal, we would regard you as a great pacificator.

Arbitrary Demand for Changed Methods of Sanitation.

The demand made upon the Sanitary District that it change its method of treating sewage after it had expended $66,-000,000 is analogous to requiring a public service corporation which has, at great cost, put in a steam plant of type best known and approved at the time of its installation—triple expansion compound condensing engines, etc.—to discard the whole equipment while its usefulness and efficiency is unimpaired, and substitute therefor steam turbines.

The project of the District is designed to meet the requirements of a given population by dilution methods. When that limit of population is reached, remedial works will have been provided to care for the excess known to have accrued. There is a limit fixed to the amount of water that may be used by two governing considerations—

First—The volume which may safely be taken from Lake Michigan.

Second—The volume which may be discharged into the Illinois Valley without damaging the property adjacent to the stream.

Owner's Risk.

I do not know whether my belief based upon a natural perception of justice or whether it comes to me as the result of an aforesaid legal contamination, but I believe that when an investor with full knowledge of a certain risk that he runs, by reason of what he knows will come about as the result of certain plans of others which he has every reason to believe will be carried out, that he has no recourse at law; no action against the person or persons, corporation or municipality, which, by carrying out plans which were well known to be matured before he made his investment, cause him to lose profits which he hoped to secure.

It seems to me that the vessel owners are just in the condition of this investor. Prior to 1900 there were but 40 boats on the Great Lakes with keel length over 400 feet and all of these, except four, were less than 450 feet. The first of these to be built was the S. S. Curry, 432x45, built in 1893, when lake navigation was limited by the depth over the miter sill of the Weitzel Lock, which was 17 feet with the upper pool at 601.9, lower pool 584.4; in 1895 the Victory, 452x48, was built. Since 1900, 210 of the larger class boats have been built.

Inter-Lake Channels.

Lakes Superior and Huron are connected by the St. Mary's River Canal, the Sault Ste. Marie locks and the St. Mary's River. In 1881, when the Weitzel Lock was opened for traffic, I find the statement that with the water at elevation 601.9 in the upper pool and 584.4 in the lower pool, there were 17 feet of water over the miter sill, hence its elevation must have been 567.4. In 1881 the high level of Lake Huron 582.3. In 1887 the Poe Lock was connected; with lower miter sill at elevation 562.1 and a calculated depth of water over it of 22 feet; when this depth obtained the level of the lower pool must have been 584.1. This lock was completed in 1896, four years before the opening of the Chicago Drainage Canal. Prior to this lock being put into service the Government had been improving the lower St. Mary's River to a depth of 20 feet, greatly diminishing the slope in the St. Mary's River and thereby reducing the depth of water over the lower miter sills of the two American and the one Canadian lock. The statistical report of Lake Commerce through the St. Mary's Falls Canal for the year 1910 states that safe draft of water through the locks was only 18.4, which indicates an elevation of 580.5 for the lower pool, three feet and nine-tenths lower than the elevation of 1881.

A glance at the hydrograph for 1910 shows the extreme high water of 1910 to be just 580.5 and the mean for the months of open navigation of 580.25. To all intents for the uses of navigation the slope in the lower St. Mary's River is, therefore, wiped out. The next connecting channel is the St. Clair River, which begins in Huron and ends in Lake St. Clair.

Since the year 1900, the work of deepening and widening the interlake channels has gone steadily on. What has been accomplished in that direction is briefly but luminously set forth in Bulletin No. 20, Survey of the Northern and North-

western Lakes, published by U. S. Lake Survey Office, Detroit, Michigan, 1911, under authority of the War Department.

The present improvement dates from the project of 1867 for the construction of a straight ship channel 300 feet wide, protected by dikes, extending from deep water in the mouth of the South Pass to deep water in Lake St. Clair. This canal was formally opened July 25, 1871, although the channel had been used by vessels in the season of 1870. The original plan provided for 13 feet depth, which was modified in 1872 to 16 feet, and in 1886 to 18 and 20 feet. The river and harbor act of June 13, 1902, provided for two separate channels for up and down-bound traffic, by the excavation of a new channel 20 feet deep and 300 feet wide along the west side of the old canal. This west channel was opened to navigation September 3, 1906.

The existing canal consists of two channels above mentioned, extending from the mouth of the South Channel into Lake St. Clair a distance of 17,460 feet. For a distance of 7,221 feet at the upper end, the two channels are separated by a sand dike 100 feet wide, revetted by sheet piling, and the old or east channel is enclosed on its east side by a similar dike 50 feet wide. The old east channel is 292 feet wide between the dikes and the west channel is 300 feet wide. Below the dikes the two channels are combined with a uniform width of 750 feet. The depth of the channel is 20 feet.

Lower Detroit River. At Ballard's Reef there are occasional fluctuations in depths of from 3 to 5 feet, produced by high easterly or westerly winds which respectively raise or lower the water level at the west end of Lake Erie and similarly affect the level of the lower river. Display stations to show the depth existing at Ballard's Reef are maintained at Sandwich coal dock, at Smith's coal dock near Rogue River, and at Elliott Point about opposite the foot of Bois Blanc Island. During the season of 1910, the lowest mean depth in the river for any month was 19.7 feet, this being at Ballard's Reef.

Approved projects provide for the deepening of the present channel to 21 feet for a width of 600 feet from the head of Ballard's Reef to Bar Point, and for the same depth for 800 feet width from Bar Point to deep water in Lake Erie; also for a second channel (Livingstone Channel) of 22 feet depth and 300 feet width from Ballard's Reef to Bar Point, passing to the west of the Bois Blanc Island, and for the same

depth for 800 feet width from Bar Point to deep water in Lake Erie. The latter project will not be completed before 1912.

The conditions of the improved ship channels of the lower river, as existing at the beginning of the season of 1911, are described below.

Ballard's Reef. The channel is 600 feet wide, nad its center line is marked by the Grosse Isle South Channel Range. The preeant improved depth is 19.5 feet, with work in progress to secure 21 feet depth south of the junction with Livingstone Channel and 22 feet depth north of this junction. On account of these improvements, navigation will be restricted to 300 feet width during the season of 1911, and such portion of the channel will be marked by gas buoys with additional spar buoys when necessary.

Lime Kiln Crossing. The channel is 600 feet wide and 21 feet deep. A line 150 feet from the west side of the channel is marked at the north end by two lighted targets, one on Texas Dock and the other on the Canadian shore; and at the south end by two lighted targets placed on stakes driven in the water near the east short of Bois Blanc Island. A line 150 feet from the east side of the channel is marked at the north end by two lighted targets on the Canadian shore south of Texas Dock.

Amherstburg Reach. The channel is 600 feet wide, and 21 feet deep, except for an area about 100 feet square in its west half at the head of Bois Blanc Island where the least depth is 20 feet; the center line is marked by two light towers on Elliott Point. Just south of the intersection of Amherstburg Reach and Hackett Range, and east of the channel, is an anchorage basin 2,000 feet long and 300 feet wide, with 19.5 feet depth, marked on its easterly limit by four red spar buoys.

Hackett Range. The channel is 600 feet wide and 21 feet deep, except of an area of about 500 feet long and 100 feet wide in its east half abreast of Elliott Point, where the least depth is 20.5 feet; the center line is marked by two light towers at Amherstburg.

Bar Point Shoal. The improved channel through this shoal is 600 feet wide and 21 feet deep to the Detroit River lighthouse. For an additional 400 feet width to the westward there is 21 feet depth to deep water in Lake Erie in a straight channel passing to the west of the lighthouse. There is also a channel of 800 feet width and 22 feet depth to deep water in Lake Erie passing to the east of the lighthouse.

The Treaty.

Article V of the Treaty plainly recognized the recommendations of the International Waterways Commission in making the amount of water which may be taken on the Canadian side for power purposes as thirty-six thousand cubic feet per second.

For power purposes within the state of New York, it permits the use of water up to twenty thousand cubic feet per second. The allotment to the Sanitary District was evidently regarded as res adjudicata.

Article VIII clearly defines the uses for which water may be taken and gives their order of precedence.

(1) Use for domestic purposes.

(2) Uses for navigation, including the service of canals for the purposes of navigation.

(3) Uses for power and irrigation purposes.

And further safeguards the Sanitary District of Chicago by the sentence, 'The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boundary.'

In other words, the limitations of the Treaty were not intended to be retroactive. The Sanitary District, proceeding under a definitely and widely known plan, had been in actual operation for ten years and five months nearly, before the ratifications of the Treaty were exchanged.

I am firm in this view, because it is unthinkable that men worthy of citizenship should neglect the conservation of the lives of the people of their land and only give a care to the commercial interests of a few.

The State of Illinois is before your judgment seat because 40 per cent. of her people are charged with reducing the level of the Great Lakes. The quotations that I have made from official documents of this government show that under the direction of the United States Engineer Corps, by order of congress, work has been done in these interlake channels which has caused a reduction of lake levels vastly greater than has resulted, or can ever result, from the work of the Sanitary District of Chicago. The bulletin for the northern and northwestern lakes for 1905 showed a flow of 206,400 c.f.s. through the St. Clair River with Huron at elevation 581.40; the bulletin for 1911 showed a flow of 210,000 c.f.s. with Huron at elevation 581.28, that is, with a lake level reduced 12/100 of a foot the flow increased 3,600 c.f.s. These conditions are no

secret. During General Alexander McKenzie's term, as chief of engineers, I asked why he should object so to what we were doing when so much greater damage was being done to lake levels under his direction. His reply was, 'What I am doing is by order of congress.' On Dec. 9, 1909, I had this matter up with General Marshall, then chief of engineers. He said that he believed we would lose our lake level case; but he said, further, that he 'did not see why the government should make such a stir about what the district is doing when its own work is doing so much more to lower the lake levels.' He cited the lowering of the St. Mary's River and consequent diminished depth over miter sills on the Sault Ste. Marie locks resulting from improving the channel. But he said the remedy by control is simple and easy. Right here I will say that it has been a source of infinite satisfaction to me to deal with the members of the United States Engineer Corps who have ascertained and preserved the facts essential to an intelligent discussion of these matters. They have been frank and courteous with me, concealing no fact within their knowledge which has a bearing upon these discussions. They regard these facts from a viewpoint different from my own and my effort now is to have you see the merits and equities as I view them.

Mr. Secretary, none of the protestants who have filed objections or appeared personally before you, has proved, or can prove, that they have been damaged. They have presented what they fear they may suffer, not what they have suffered.

Now, I would not leave a doubt in your mind as to what Illinois wants.

The question has been raised—For how long a time is this water wanted?

As long as water runs down hill or floats a boat, Illinois wants this water. She wants it for the health and life of her people; she wants it for her own water-borne commerce and for that of her sister states; she wants it for the power that it will yield; she wants it for the fish that it will produce to feed all the people; she wants it now, henceforth and forever.

Now, Mr. Secretary, can you attach more importance to the desire of a few score people to secure large interest on their investments than to the claims that two and one-quarter million people have upon the use of their investment of $66,000,000—not for gain, but for health and life?

I have confidence that the call of humanity will prevail with you over the clamor of the captains of marine industry for more gain. We have spent our millions to preserve human life. They are piling up millions as an outcome of the expenditure of the people's money, in making deep channels between the 'unsalted seas.'

THE STATE OF ILLINOIS,
By ISHAM RANDOLPH,
Commissioned by Governor Charles S. Deneen to appear for the State."

EXHIBITS WITH BRIEF

OF THE

STATE OF ILLINOIS

IN BEHALF OF

The Sanitary District of Chicago.

APRIL 3, 1912.

EXHIBITS WITH BRIEF.

OWNER OR MANAGER	NAME	Tons per inch of draft	Keel and beam	Built
A				
Acme Steamship Co., Duluth, Minn.	Ward Ames	70.0	540x56x31	1906
American Transit Co., Syracuse, N. Y.	John Dunn, Jr.	66.4	504x56x30	1907
B				
Becker, W. H., Cleveland, Ohio	Edwin N. Ohl	53.1	430x54x28	1907
Becker, W. H.	W. G. Pollock	51.8	430x52x28	1906
Becker, W. H.	Joshua W. Rhodes	51.8	430x52x28	1906
Becker, W. H.	Alexis W. Thompson	64.9	504x56x30	1906
Becker, W. H., manager Interstate Steamship Co.	James Laughlin	60.5	530x56x31	1906
Becker, W. H., manager Columbia Steamship Co.	Francis Widlar	45.7	416x50x28	1904
Bolands, Cornelius, Buffalo, N. Y.	Adam E. Cornelius	51.3	430x52x28	1906
Bolands, Cornelius, manager, Pennsylvania Steamship Co.	Jacob F. Kops	60.7	480x54x30	1907
Bolands, Cornelius, manager, American Steamship Co.	Clifford F. Mott	56.2	444x56x28	1909
Bolands, Cornelius	Theodore H. Wickwire	66.2	544x56x28	1909
Boland, J. J., manager, York Steamship Co., Buffalo, N. Y.	John J. Boland	60.7	480x54x30	1907
Bradley, M. A., manager, Alva Steamship Co., Cleveland, Ohio	M. A. Bradley	56.0	480x52x30	1906
Brown, J. J. H., Buffalo, N. Y.	G. A. Tomlinson	63.7	504x54x—	1906
Brown Steamship Co., Buffalo, N. Y.	J. J. H. Brown	53.5	452x52x28	1906
C				
Cambria Steamship Co., M. A. Hannah & Co., managers, Cleveland, Ohio.	Daniel J. Morrell	78.8	580x58x32	1906
Cambria Steamship Co., M. A. Hannah & Co., managers, Cleveland, Ohio.	Edward Y. Townsend	78.8	580x58x32	1906
Carter, E. D., Erie, Pa.	J. H. Bartow	63.7	504x54x30	1907
Carter, E. D., Erie, Pa.	E. D. Carter	63.7	504x54x30	1906
Chicago Navigation Co., Chicago, Ill.	J. S. Dunham	51.3	430x52x28	1905
Chicago Navigation Co., Chicago, Ill.	W. E. Fitzgerald	51.2	430x52x28	1906
Cleveland Cliffs Iron Co., Cleveland, Ohio	Wm. G. Mather	73.0	512x60x31	1905
Cleveland Cliffs Iron Co., managers, Grand Island Steamship Co.	Ishpeming	66.5	530x56x31	1906
Cleveland Cliffs Iron Co., managers, Grand Island Steamship Co.	Michigan	66.5	530x56x31	1906
Cleveland Cliffs Iron Co., managers, Grand Island Steamship Co.	J. H. Sheadle	66.5	530x56x31	1906
Cleveland Cliffs Iron Co., managers, Pr. Isle Transportation Co.	Angeline	60.4	414x51x28	1906
Cleveland Cliffs Iron Co., managers, Pr. Isle Transportation Co.	Peter White	63.7	504x54x30	1906
Cleveland Cliffs Iron Co., managers, Pr. Isle Transportation Co.	Presque Isle	47.8	406x50x28	1906
Cowle T., Co., Cleveland, Ohio	John B. Cowle (sunk)		416x50x28	1902
Croxton Steamship Co., S. P. Crosage, manager, Bay City, Mich.	Caldera	63.7	504x54x30	1905
Cummings, Michael J., Oswego, N. Y.	Western Star	63.7	416x50x28	1903

Exhibits with brief—Continued.

OWNER OR MANAGER	NAME	Tons per inch of draft	Keel and beam	Built
D				
D. & C. Navigation Co., Detroit, Mich., (see also A. B. Wolvin)	City of Cleveland	49.9	420x50x28	1907
Detroit Steamship Co., J. H. Walsh, manager, Detroit, Mich	C. W. Kotcher	51.3	430x52x28	1907
Dearborn Transit Co., Dearborn, Mich	R. L. Wallace	51.3	420x50x28	1908
E				
Elphicke & Co., Chicago, Ill., managers of Federal Steamship Co.	W. L. Brown	50.3	436x50x30	1901
Elphicke & Co., Chicago, Ill., managers of Federal Steamship Co.	Mary C. Elphicke	50.3	436x50x30	1901
Elphicke & Co., Chicago, Ill., managers of Cornell Steamship Co.	John Mitchell	51.3	420x52x28	1908
Empire Steamship Co., Boland & Co., managers, Buffalo, N. Y	Wm. H. Truesdale	58.5	432x52x28	1908
F				
Franklin Steamship Co., D. Sullivan, managers, Chicago, Ill.	E. J. Earling	66.9	579x58x31	1908
Fremont Steamship Co., H. K. Oakes, managers, Detroit, Mich.	B. F. Berry	48.4	480x52x30	1908
Frontier Steamship Co., W. M. Mills, managers, Tonawanda, N. Y	James Corrigan	60.5	530x56x31	1908
Frontier Steamship Co., W. M. Mills, managers, Tonawanda, N. Y	Daniel B. Meacham	60.5	530x56x31	1908
Frontier Steamship Co., W. M. Mills, managers, Tonawanda, N. Y	Josiah G. Munro	60.5	530x56x31	1907
G				
Gartland Steamship Co., D. Sullivan, manager, Chicago, Ill.	William H. Wolf	63.7	504x54x30	1908
Gilchrist Transportation Co., Cleveland, Ohio	Geo. Garretson	65.7	530x54x31	1908
Gilchrist Transportation Co., Cleveland, Ohio	F. W. Gilchrist	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	Jos. C. Gilchrist	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	Frank J. Hecker	54.3	464x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	R. I. Ireland	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	H. P. McIntosh	65.7	530x54x31	1908
Gilchrist Transportation Co., Cleveland, Ohio	Geo. H. Russell	54.3	464x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	R. E. Schuck	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	John Sherwin	65.0	514x54x31	1908
Gilchrist Transportation Co., Cleveland, Ohio	Perry G. Walker	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	J. L. Weeks	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	David M. Whitney	47.3	404x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	Jas. B. Wood	65.0	514x54x31	1908
Gilchrist Transportation Co., Cleveland, Ohio	Lewis Woodruff	48.7	416x50x28	1908
Gilchrist Transportation Co., Cleveland, Ohio	H. S. Hill	48.7	416x50x28	1908

H				
Hawgood, W. A., Cleveland, Ohio	Bransford	48.4	414x50x28	1902
Hawgood, Arthur H., Cleveland, Ohio	S. S. Curry	45.5	423x48x26	1903
Hawgood, W. A. & A. H., Cleveland, Ohio	H. D. Goulder	67.6	532x56x31	1906
Hawgood, W. A. & A. H., Cleveland, Ohio	Edwin F. Holmes	60.0	480x50x28	1904
Hawgood, W. A. & A. H., Cleveland, Ohio	J. M. Jenks	48.4	414x50x28	1903
Hawgood, W. A. & A. H., Cleveland, Ohio	Sheldon Parks	69.7	532x56x31	1906
Hawgood, W. A. & A. H., Cleveland, Ohio	Henry B. Smith	67.6	532x56x31	1906
Hawgood, W. A. & A. H., Cleveland, Ohio	Abraham Stearn	67.6	532x56x31	1906
Hawgood, W. A. & A. H., Cleveland, Ohio	W. R. Woodford	69.7	532x56x31	1906
Hawgood, W. A. & A. H., Cleveland, Ohio	Umbria	60.0	480x50x28	1904
Hawgood, W. A. & A. H., managers, Atlas Steamship Co., Cleveland, Ohio	Wm. A. Hawgood	69.7	532x56x31	1907
Hawgood, W. A. & A. H., managers, Holmes Steamship Co., Cleveland, Ohio	Salt Lake City	69.7	532x56x31	1907
Hawgood, W. A. & A. H., managers, Milwaukee Steamship Co., Cleveland, Ohio	J. Q. Riddle	69.7	532x56x31	1906
Hawgood, W. A. & A. H., managers, Minerva Steamship Co., Cleveland, Ohio	Henry A. Hawgood	69.7	532x56x31	1906
Hawgood, W. A. & A. H., managers, Neptune Steamship Co., Cleveland, Ohio	Arthur H. Hawgood	73.0	548x56x31	1907
Hawgood, W. A. & A. H., managers, Wisconsin Steamship Co., Cleveland, Ohio	Wisconsin	60.0	480x50x28	1906
Hawgood Transit Co., Cleveland, Ohio	H. B. Hawgood	48.4	414x50x28	1903
Hutchinson, C. L. & Co., Cleveland, Ohio	Joseph G. Butler	67.6	532x55x31	1905
Hutchinson, C. L. & Co., Cleveland, Ohio	John A. McGean	63.5	452x52x28	1908
Hutchinson, C. L. & Co., Cleveland, Ohio	Marton Mullen	48.7	416x50x28	1904
Hutchinson, C. L. & Co., Cleveland, Ohio	William A. Paine	58.4	480x52x30	1905
Hutchinson, C. L. & Co., Cleveland, Ohio	John Stanton	63.7	504x54x27	1906
Hutchinson, C. L. & Co., managers, Pioneer Steamship Co., Cleveland, Ohio	A. A. Augustus	63.7	504x54x—	1910
Hutchinson, C. L. & Co., managers, Pioneer Steamship Co., Cleveland, Ohio	D. R. Hanna	69.7	532x56x31	1906
Hutchinson, C. L. & Co., managers, Superior Steamship Co., Cleveland, Ohio	J. J. Sullivan	69.7	532x56x31	1907
I				
Interstate Steamship Co., J. M. St. Clair, Duluth, Minn.	B. F. Jones	69.5	530x56x31	1906
Jenkins Steamship Co., Cleveland, Ohio	Chas. O. Jenkins	63.7	504x54x30	1907
Jenkins Steamship Co., Cleveland, Ohio	F. B. Squire	48.0	416x50x28	1903
Jenkins, C. O., Cleveland, Ohio	Sir Thomas Shaughnessy	58.4	498x52x30	1906
Jenkins, C. O., manager, Ohio Steamship Co., Cleveland, Ohio	Jas. P. Walsh	58.4	480x52x30	1905
K				
Kinney Steamship Co., Cleveland, Ohio	J. S. Ashley	63.7	504x54x—	1909
Kinsman Transit Co., H. Steinbrenner, manager, Cleveland, Ohio	Mathew Andrews	69.7	532x56x31	1907
Kinsman Transit Co., H. Steinbrenner, manager, Cleveland, Ohio	Phillip Minch	58.4	480x52x30	1905
Kinsman Transit Co., H. Steinbrenner, manager, Cleveland, Ohio	Henry Steinbrenner	48.7	416x50x28	1901

Exhibits with brief—Continued.

OWNER OR MANAGER	NAME	Tons per inch of draft	Keel and beam	Built
L				
LaBelle Steamship Co., J. S. Ashley, secretary, Cleveland, Ohio	LaBelle	53.7	504x54x—	[illegible]
Lake Transit Co., The, H. L. Shaw, manager, Bay City, Mich	City of Bangor	46.9	445x44x28	[illegible]
Lake Transit Co., The, H. L. Shaw, manager, Bay City, Mich	Penobscot	45.5	442x44x28	[illegible]
M				
Mahoning Steamship Co., J. S. Ashley & Co., managers, Cleveland, Ohio	Leonard C. Hanna	63.7	504x54x30	1905
Mahoning Steamship Co., J. S. Ashley & Co., managers, Cleveland, Ohio	Powell Stackhouse	62.7	504x54x30	1905
Manila Steamship Co., J. Sellwood, manager, Duluth, Minn	Joe S. Morrow	51.1	430x52x28	[illegible]
Maumee Steamship Co., W. White, manager, Cleveland, Ohio	Denmark	57.7	440x54x—	[illegible]
McMillan, P. H., manager, Wolverine Steamship Co., Detroit, Mich	Senator	44.0	410x46x28	[illegible]
McMillan, M. B., Detroit, Mich	Admiral	51.3	430x52x28	[illegible]
Millinokett Steamship Co., H. L. Shaw, manager, Bay City, Mich	Millinokett	51.0	504x52x30	[illegible]
Mehl, Edward, Erie, Pa	Wainwright	51.3	[illegible]	[illegible]
Mitchell, John, Cleveland, Ohio	Hugh Kennedy	60.7	[illegible]	[illegible]
Mitchell, John, Cleveland, Ohio	Loftus Cuddy	57.6	532x56x31	[illegible]
Mitchell, John, Cleveland, Ohio	Joseph Sellwood	57.6	532x56x31	[illegible]
Mitchell, John, Cleveland, Ohio	Stephen M. Clement	55.4	480x52x30	[illegible]
Mitchell, John, Cleveland, Ohio	John J. Albright	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	E. A. S. Clarke	45.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	James Gayely	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Frank H. Goodyear	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Wm. H. Gratwick	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Wm. E. Reiss	46.7	410x50x28	1900
Mitchell, John, Cleveland, Ohio	Walter Scranton	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Moses Taylor	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Pendennis White	46.7	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	M. A. Hanna	48.0	410x50x28	[illegible]
Mitchell, John, Cleveland, Ohio	Hendrick S. Holden	47.8	[illegible]	[illegible]
N				
National Steamship Co., Detroit, Mich	W. K. Bixby	58.4	480x52x30	1906
Niagara Transit Co., W. M. Mills, manager, N. Tonawanda, N. Y	Wm. A. Rogers	67.6	532x56x31	[illegible]

Pickands, Mather & Co., Cleveland, Ohio	D. O. Mills	73.3	[illegible]	1896
Pickands, Mather & Co., Cleveland, Ohio	Jay C. Morse	73.3	[illegible]	1896
Pickands, Mather & Co., Cleveland, Ohio	Amasa Stone	67.6	[illegible]	[illegible]
P. M. & Co., managers, Ashtabula Steamship Co., Cleveland, Ohio	Normania	51.3	[illegible]	[illegible]
P. M. & Co., managers, Inter Lake Steamship Co., Cleveland, Ohio	Constitution	46.3	[illegible]	1907
P. M. & Co., managers, Inter Lake Steamship Co., Cleveland, Ohio	Victory (rebuilt 1906)	50.3	[illegible]	[illegible]
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Crete	58.4	[illegible]	1907
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Verona	58.4	[illegible]	1907
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Adriatic	51.2	[illegible]	[illegible]
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Calumet	51.3	[illegible]	[illegible]
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Elba	51.3	[illegible]	[illegible]
P. M. & Co., managers, Lackawanna Steamship Co., Cleveland, Ohio	Hemlock	51.2	[illegible]	[illegible]
P. M. & Co., managers, Mesaba Steamship Co., Cleveland, Ohio	Odanah	41.3	[illegible]	1907
Pittsburg Steamship Co., Cleveland, Ohio	Samuel Mather	74.4	[illegible]	1906
Pittsburg Steamship Co., Cleveland, Ohio	Geo. F. Baker	73.4	[illegible]	1907
Pittsburg Steamship Co., Cleveland, Ohio	Thos. Lynch	63.9	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Alva C. Dinkey	79.1	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Eugene J. Buffington	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Thomas F. Cole	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	John P. Morgan, Jr	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	J. Pierpont Morgan	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Henry Phipps	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Norman B. Ream	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Henry H. Rogers	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Wm. B. Schiller	76.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Peter A. Widener	73.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Wm. E. Corey	73.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Henry C. Frick	73.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Elbert H. Gary	73.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Geo. W. Perkins	73.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Wm. Edenborn	58.0	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	Isaac L. Elwood	58.0	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	John W. Gates	58.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	James J. Hill	58.0	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	Gen. Orlando M. Poe	58.0	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	Douglas Houghton	53.4	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Samuel F. B. Morse	53.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Cornell	58.1	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Harvard	58.1	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Princeton	58.1	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Rensselaer	58.1	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	Malietoa	58.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	John Smeaton	53.3	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Chas. Van Hise	53.3	[illegible]	1900
Pittsburg Steamship Co., Cleveland, Ohio	Robt. W. Bunsen	51.4	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	John Fritz	51.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Manila	51.0	[illegible]	[illegible]
Pittsburg Steamship Co., Cleveland, Ohio	Marcia	51.0	[illegible]	1900

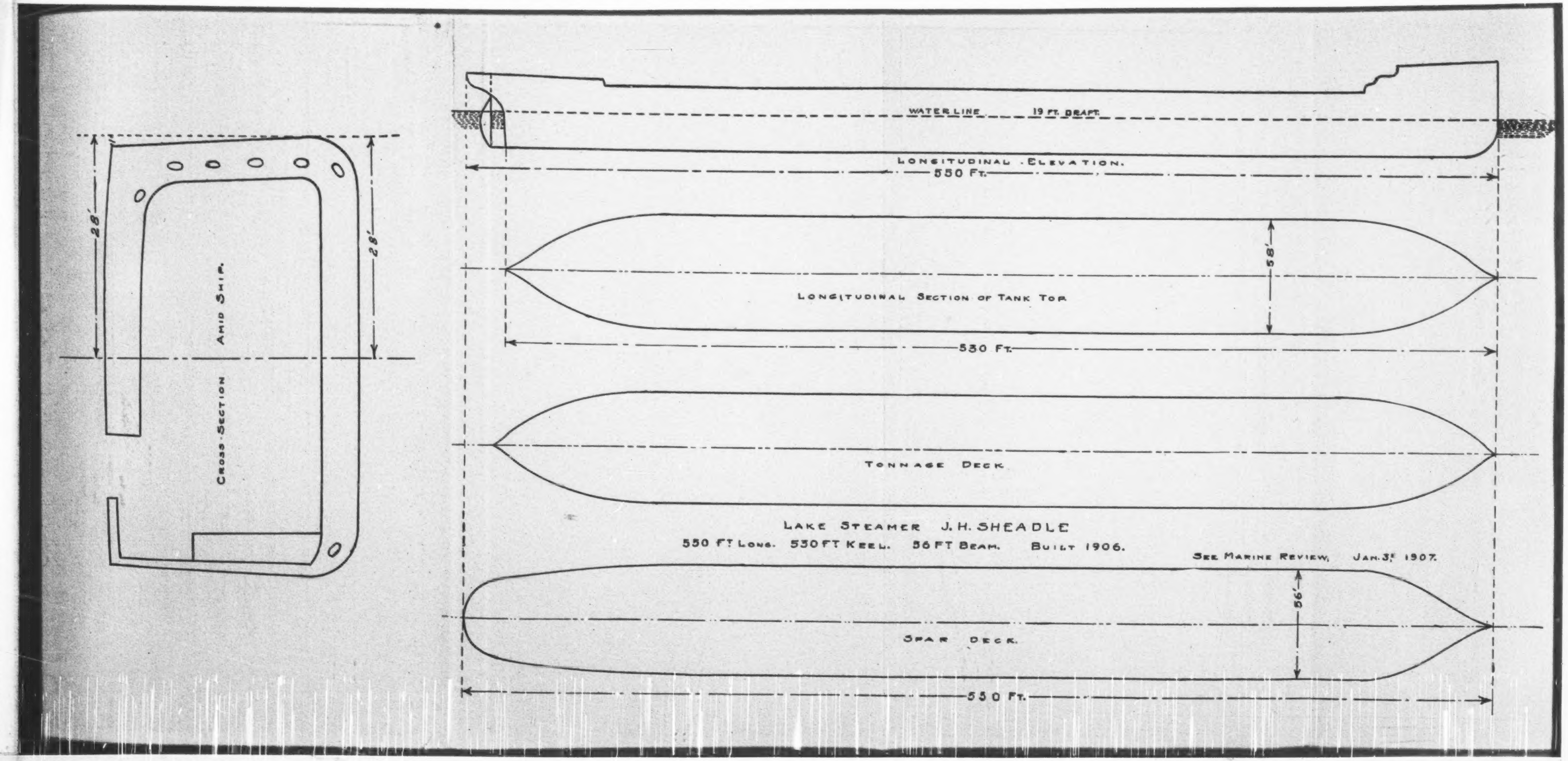
Exhibits with brief—Continued.

OWNER OR MANAGER	NAME	Tons per inch of draft	Keel and beam	Built
Pittsburg Steamship Co., Cleveland, Ohio	John A. Roebling	50.0	435x46x33	1898
Pittsburg Steamship Co., Cleveland, Ohio	Mataafa	50.3	480x50x29	1898
Pittsburg Steamship Co., Cleveland, Ohio	Mauna Loa	50.3	480x50x29	1898
Pittsburg Steamship Co., Cleveland, Ohio	Superior City	50.3	480x50x29	1898
Pittsburg Steamship Co., Cleveland, Ohio	Simon J. Murphy	50.0	436x50x28	1900
Pittsburg Steamship Co., Cleveland, Ohio	Howard L. Shaw	50.0	436x50x28	1900
Pittsburg Steamship Co., Cleveland, Ohio	Sir Wm. Fairbairn	48.0	432x46x28	1896
Pittsburg Steamship Co., Cleveland, Ohio	Robert Fulton	44.6	414x48x28	1893
Pittsburg Steamship Co., Cleveland, Ohio	Alex. McDougall	46.4	414x50x27	1898
Pittsburg Steamship Co., Cleveland, Ohio	Sir H. Bessemer	46.3	412x48x26	1896
Pittsburg Steamship Co., Cleveland, Ohio	Clarence A. Black	40.3	412x50x26	1898
Pittsburg Steamship Co., Cleveland, Ohio	Coralia	46.3	412x48x26	1895
Pittsburg Steamship Co., Cleveland, Ohio	Sir Wm. Siemens	46.3	412x48x26	1896
Pittsburg Steamship Co., Cleveland, Ohio	Geo. Stephenson	47.0	408x48x26	1898
Pittsburg Steamship Co., Cleveland, Ohio	John B. Trevor	38.0	408x38x24	1895
Pittsburg Steamship Co., Cleveland, Ohio	Crescent City	45.6	400x48x26	1897
Pittsburg Steamship Co., Cleveland, Ohio	Empire City	45.6	400x48x26	1897
Pittsburg Steamship Co., Cleveland, Ohio	Maricopa	45.6	400x48x26	1896
Pittsburg Steamship Co., Cleveland, Ohio	James Watt	45.6	400x48x26	1896
Pittsburg Steamship Co., Cleveland, Ohio	Bryn Mawr	47.0	400x50x27	1900
Pittsburg Steamship Co., Cleveland, Ohio	Jos. B. Eads	40.3	400x42x26	1894
Pittsburg Steamship Co., Cleveland, Ohio	Wm. R. Linn	45.0	400x48x26	1898
Pittsburg Steamship Co., Cleveland, Ohio	Queen City	45.0	400x48x28	1896
Postal Steamship Co., Detroit, Mich	Jno. J. Barlum	62.7	504x54x30	1909
Postal Steamship Co., Detroit, Mich	Thomas Barlum	58.4	480x52x30	1907
R				
Rardon, J. J., Chicago, Ill	Price McKinney	53.1	420x54x26	1906
Reiss Coal Co., Sheboygan, Wis	John P. Reiss	75.6	534x54x—	1909
Richardson, W. C. & Co., Cleveland, Ohio	David Z. Norton	55.4	480x52x26	1906
Richardson, W. C., Manager Hannah Transit Co., Cleveland, Ohio	Howard M. Hanna, Jr	60.7	480x54x30	1908
Roby Transportation Co., L. C. Waldo, Manager, Detroit, Mich	L. C. Waldo	50.8	451x48x28	1896
S				
Seither Transit Co., Cleveland, Ohio	G. J. Grammer	48.5	434x48x28	1906
Smith, L. C. Transit Co., Syracuse, N. Y	Harry Coulby	72.0	540x56x31	1906
Smith, L. C. Transit Co., Syracuse, N. Y	Thompson Smith	55.6	480x52x28	1906
Shenango Steamship Co., W. B. Davock, Manager, Cleveland, Ohio	Shenango	79.5	586x58x30	1909
Shenango Steamship Co., W. B. Davock, Manager, Cleveland, Ohio	Wm. P. Snyder	60.5	530x56x31	1906

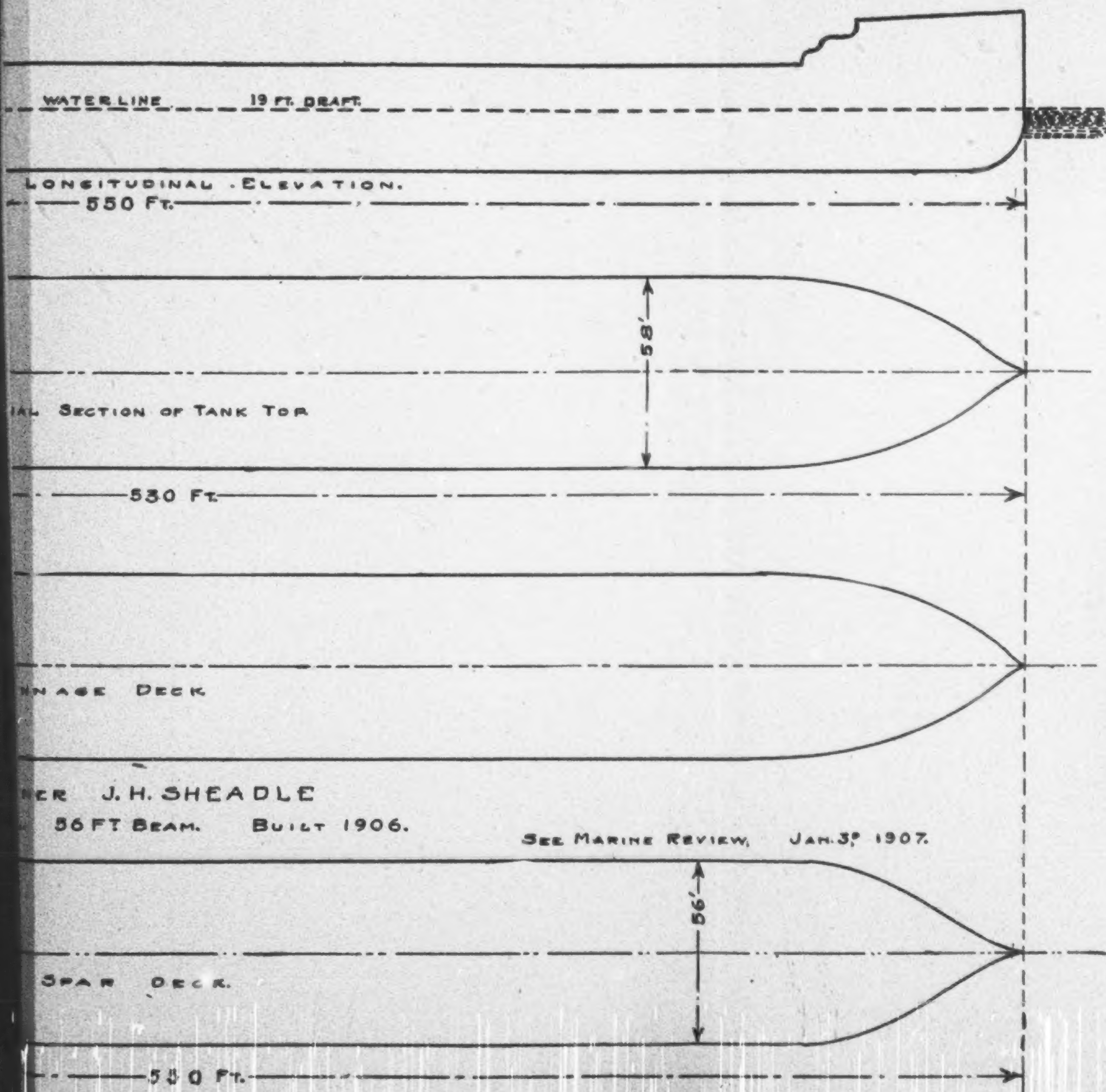
Shenango Steamship Co., W. B. Davock, Manager, Cleveland, Ohio	Wilpen	75.2	554x58x32	1906
Stadacona Steamship Co., Michigan City, Ind	Stadacona	63.8	479x56x—	1909
Starke, Christopher H., Milwaukee, Wis	Christopher	46.0	410x48x28	1901
Sullivan, Estate of L. S., Toledo, Ohio	Eugene Zimmerman	56.4	480x52x30	1906
T				
Tomlinson, G. A., Duluth, Minn	Ball Bros.	56.4	480x52x30	1906
Tomlinson, G. A., Duluth, Minn	Frank C. Ball	69.5	530x56x31	1906
Tomlinson, G. A., Duluth, Minn	Hoover & Mason	63.7	504x54x30	1906
Tomlinson, G. A., Duluth, Minn	Sahara	57.7	474x52x29	1907
Tomlinson, G. A., Duluth, Minn	Saxona	48.7	416x50x28	1903
Tomlinson, G. A., Duluth, Minn	Sicola	48.7	416x50x28	1903
Tomlinson, G. A., Duluth, Minn	Socapa	63.7	504x54x30	1906
Tomlinson, G. A., Duluth, Minn	Sonoma	48.7	416x50x28	1903
Tomlinson, G. A., Duluth, Minn	Sylvania	63.7	504x54x30	1906
Tomlinson, G. A., Manager Inter Ocean Steamship Co., Duluth, Minn	J. E. Davidson	63.7	504x54x30	1906
Tomlinson, G. A., Manager Inter Ocean Steamship Co., Duluth, Minn	Sierra	52.6	436x52x28	1906
Tomlinson, G. A., Manager Mutual Steamship Co., Duluth, Minn	Harry A. Berwind	72.2	532x58x31	1906
Tomlinson, G. A., Manager Mutual Steamship Co., Duluth, Minn	Fred G. Hartwell	68.4	504x58x30	1906
Tomlinson, G. A., Manager Mutual Steamship Co., Duluth, Minn	Wm. Livingstone	72.2	532x58x31	1908
Tonawanda Transit Co., Tonawanda, N. Y	Charles A. Weston	72.0	540x56x31	1908
Triton Steamship Co., J. R. Davock & Co., Managers, Cleveland, Ohio	Rufus P. Ranney	51.3	430x52x28	1906
U				
U. S. Transportation Co., Cleveland, Ohio	Charles Hubbard	52.6	436x52x28	1907
U. S. Transportation Co., Cleveland, Ohio	Hurlbut W. Smith	49.4	414x50x28	1908
U. S. Transportation Co., Cleveland, Ohio	Lyman C. Smith	67.6	536x56x31	1905
U. S. Transportation Co., Cleveland, Ohio	L. C. Smith	46.4	414x50x28	1903
U. S. Transportation Co. (See, also, Wilkinson Transportation Co.)				
V				
Virginia Steamship Co., J. S. Ashley, Secretary, Cleveland, Ohio	Isaac M. Scott	63.7	504x54x—	1909
Vulcan Steamship Co., Cleveland, Ohio	Wm. B. Davock	51.3	430x52x28	1906
W				
Wilson Transit Co., Cleveland, Ohio	Andrew Carnegie	45.3	408x48x28	1907
Wilson Transit Co., Cleveland, Ohio	Chas. S. Hebard	63.7	504x54x30	1906
Wilson Transit Co., Cleveland, Ohio	J. E. Upson	63.7	504x54x30	1908
Wilson Transit Co., Cleveland, Ohio	Capt. Thos. Wilson	48.7	416x50x28	1900
Wilson Transit Co., Cleveland, Ohio	Henry W. Oliver	53.0	444x50x28	1901
Weston Transit Co., N. Tonawanda, N. Y	Le Grande S. De Graffe	83.2	586x60x32	1908
Weston Transit Co., N. Tonawanda, N. Y	Wm. B. Kerr	83.2	586x60x32	1906
Weston Transit Co., N. Tonawanda, N. Y	Wm. M. Mills	83.2	586x60x32	1906
Wilkinson Transportation Co., U. S. Transportation Co., Managers, Cleveland, Ohio	J. P. Durston	52.5	433x52x28	1906
Wilkinson Transportation Co., U. S. Transportation Co., Managers, Cleveland, Ohio	A. E. Nettleton	67.6	536x56x31	1908
Wolvin, A. B., Duluth, Minn., Manager Acme Steamship Co	James C. Wallace	69.7	533x56x31	1906

Exhibits with brief—Concluded.

OWNER OR MANAGER.	NAME.	Tons per inch of draft	Keel and Beam	Built
Wolvin, A. B., Duluth, Minn., Manager Acme Steamship Co.	Augustus B. Wolvin	70.5	540x56x32	1904
Wolvin, A. B., Duluth, Minn., Manager Peavey Steamship Co.	F. T. Heffelfinger	50.3	430x50x29	1901
Wolvin, A. B., Duluth, Minn., Manager Peavey Steamship Co.	Frank H. Peavey	50.3	430x50x29	1901
Wolvin, A. B., Duluth, Minn., Manager Peavey Steamship Co.	Geo. W. Peavey	50.3	430x50x29	1901
Wolvin, A. B., Duluth, Minn., Manager Peavey Steamship Co.	Frederick B. Wells	50.3	430x50x29	1901
Wolvin, A. B., Duluth, Minn., Manager Provident Steamship Co.	D. G. Kerr	54.5	448x52x28	1903
Wolvin, A. B., Duluth, Minn., Manager Provident Steamship Co.	Jas. H. Reed	54.5	448x52x28	1903
Wolvin, A. B., Duluth, Minn., Manager Standard Steamship Co.	H. P. Bope	70.9	540x56x30	1907



28'
28'
Cross-Section Amid Ship.
Water Line 19 Ft. Draft
Longitudinal Elevation.
550 Ft.
58'
Longitudinal Section of Tank Top
530 Ft.
Tonnage Deck
Lake Steamer J. H. Sheadle
550 Ft. Long. 530 Ft Keel. 56 Ft Beam. Built 1906.
See Marine Review, Jan. 3rd 1907.
56'
Spar Deck.
550 Ft.



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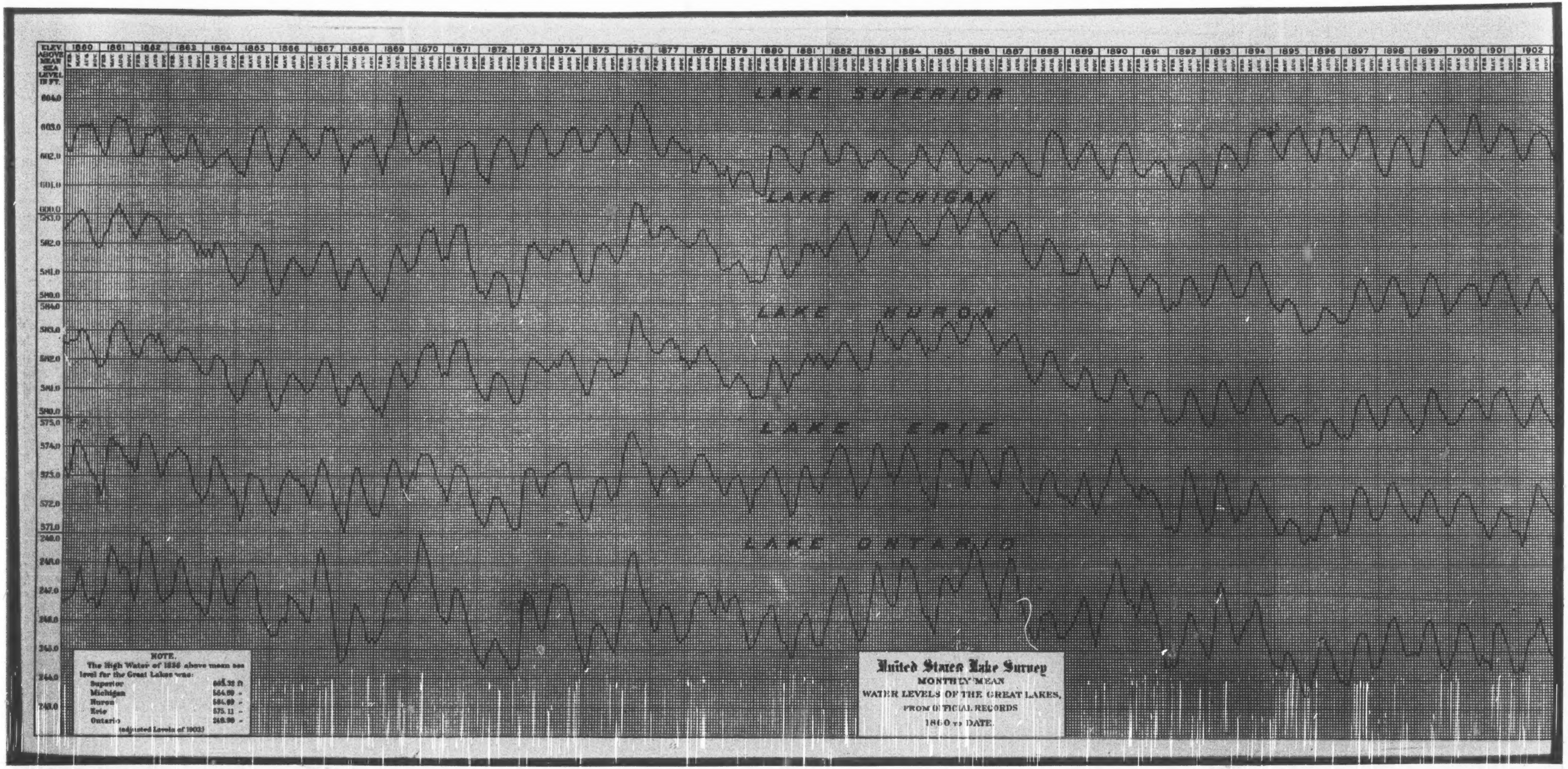
STATUTORY LENGTH, BREADTH, DEPTH & HEIGHT OF VESSELS.

Revised Statutes, Section 4150.

"The registry of every vessel shall express her length and breadth, together with her depth and height, under the third or spar deck, which shall be ascertained in the following manner:

The tonnage deck, in vessels having three or more decks to the hull shall be the second deck from below; in all other cases the upper deck of the hull is to be the tonnage deck. The length from the fore part of the outer planking on the side of the stem to the after part of the main stern-post of screw steamers and to the after part of the rudder-post of all other vessels measured on the top of the tonnage deck shall be accounted the vessel's length The breadth of the broadest part on the outside of the vessel shall be accounted the vessel's breadth of beam. A measure from the underside of the tonnage-deck plank, amidships, to the ceiling of the hold (Average thickness) shall be accounted the depth of hold."


ELEV. ABOVE MEAN SEA LEVEL IN FT.
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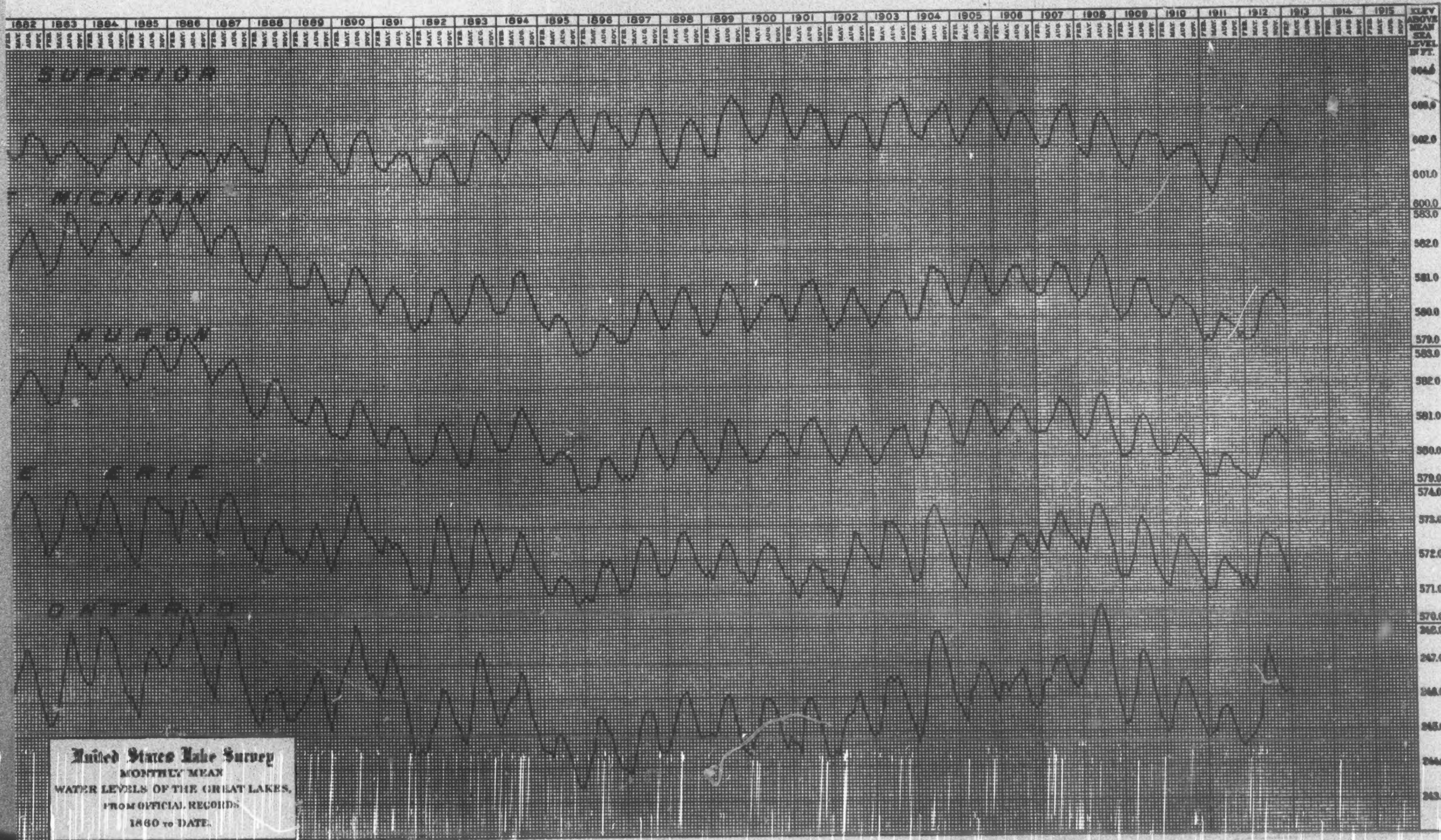
1900
1901
1902
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
NOTE.
The High Water of 1838 above mean sea level for the Great Lakes was:
Superior
Michigan
Huron
Erie 575. 11
Ontario
(adjusted Levels of 1903)
United States Lake Survey
MONTHLY MEAN
WATER LEVELS OF THE GREAT LAKES,
FROM OFFICIAL RECORDS
1860 TO DATE.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ELEV ABOVE MEAN SEA LEVEL IN FT.
SUPERIOR
MICHIGAN
HURON
ERIE
ONTARIO
United States Lake Survey
MONTHLY MEAN
WATER LEVELS OF THE GREAT LAKES,
FROM OFFICIAL RECORDS
1860 to DATE.

Letter of Approval by C. W. Wright to President Taft, March 26, 1912.

"I write to call your attention to an international opportunity in conservation of water supply.

It might well be presented to the Canadian Commission appearing before Secretary of War, Mr. Stimson, this week, and other interests there represented at the same time. I mean the holding back the waters of Lakes Michigan and Superior during the winter months which will keep the waters of all the lakes at the proper level during the open season for shipping; also permitting Chicago the required amount of water for the sanitary canal. Hoping this will be of interest to you and other conservationsists, I am

CLERIAN M. WRIGHT,
2109 W. Polk St., Chicago, Ill."

Letter of Approval by State Water Survey of the University of Illinois, March 28, 1912.

"Owing to the limited time I did not have an opportunity to speak in behalf of the request of the Sanitary District at the hearing on February 28th. I, therefore, request the privilege of making a brief statement.

The Illinois State Water Survey has been analyzing the waters of the Illinois river for a number of years. Our investigations show that the dilution at the present time is none too great, and should the flow be decreased we are certain that a nuisance would result during parts of the year. We, also, have been in close touch with the work being done by the Sanitary District and feel that they are acting in good faith, in their experiments to determine the proper method of disposing of the sewage of the increasing population of Chicago.

It is the business of the State Water Survey to make investigations which will enable the people of the State to have a pure water supply, and it is our belief that the sewage of Chicago must be diverted from the Lake, and that the curtailment of the amount allowed would work a hardship on the citizens of Chicago.

Our observations throughout the State have brought to our attention the fact that the last two years have included the periods of the lowest water in the Mississippi river as

well as in the Great Lakes. The effect of withdrawing 10,000 cu. ft. per second of water through the drainage canal will have an inappreciable effect in lowering the level of Lake Michigan as compared with the lowering that is being produced by enlargements in the channel of the Detroit river carried out by army engineers. Statements were made that Lake Superior, which cannot be affected in the least by the drainage canal, is lower than it has been for years. Likewise the Mississippi river, even below the outlet of the Illinois river where it is augmented by the drainage canal, has, during the past year, reached the lowest stage in many years.

We sincerely hope that after careful consideration you will see fit to grant the petition of the Sanitary District, which desires to take only one-twentieth of the flow from the Great Lakes. It is our belief that any lowering of the Lake Michigan level which this withdrawal might cause can be counteracted by the construction at the outlet of Lake Huron, of wing dams instead of dredging the channel as is now the practice.

EDWARD BARTOW,
Director State Water Survey."

Letter of Approval by Federation of South End Civic Bodies, March 28, 1912.

"The portion of Chicago most concerned in the matter before you, relating to the diversion of additional water from Lake Michigan, is the southern portion of the city known as the Calumet region, lying south of 87th street. Although, Mr. Secretary, you have indicated that the discussion should relate mainly to the alleged interference with navigation that might result from the permit, I am sure that the question of human life and sanitation will not be completely ignored on the same idea that a messenger in an automobile, charged with the delivery of a message at the quickest possible time, would feel justified in swerving from his most direct course to avoid running down a troop of children.

In order that the people of the Calumet region shall benefit from the Chicago Sanitary Canal, the additional diversion requested is necessary, under the state law, to properly dilute the sewage which will be emptied into the main drainage canal by the Calumet-Sag Canal, a supplementary channel now under construction.

This district comprises a population of upwards of 200,000 people larger than that of any other city in the state save

Chicago itself. A most unfortunate condition now obtains in this section owing to a delay of many years in building the Calumet-Sag Canal. Over a million dollars was recently spent in building the 95th street sewer system, which drains a large part of the District through a ten-foot sewer which has its outfall near the mouth of the Calumet river. About two miles distant, and receiving this sewage when southerly winds or other conditions cause the flow in that direction, is the intake of a large water tunnel just completed at an expense of some $6,000,000, which conveys this effluent back to the homes of the people in the guise of drinking water. Thus our people are compelled to pay $7,000,000 for the privilege of drinking their own filth, this endless chain being forced upon us by the injunction suit of the United States against the Sanital District of Chicago, which prevented the construction of the canal which our district had had every reason to expect for many years, and in expectation of which our various drainage and water plants were planned.

We, therefore, earnestly request the granting of the permit, Mr. Secretary, for the reason that the health and very lives of our people are at stake, which is a matter of far greater importance than any real or fancied injury to navigation. We urge the full permit. If this for any reason seems inadvisable, we must earnestly request a temporary permit for a period long enough to attend to the sewage disposal in some other way, so that in the mean time we may not continue to suffer this unexpected and intolerable nuisance.

The difference in the lake levels will not be the full result of 10,000 cubic feet diversion, but only about half that amount. The present permit allows about half the requested diversion, so that where a difference of six inches has been mentioned the real difference will be only three inches. We submit that this is too small a margin to be seriously considered in a navigation proposition. No navigation worthy of the name can afford to do business upon such a difference.

We submit that the city of Chicago is entitled to keep its house in order in the manner that seems best to its own people and that it is presumptuous for any foreign interest to attempt to dictate the sanitary policy of this city. If there may be an injury to navigation upon a difference in lake levels of three inches, the compensation for that damage is threefold: controlling works, deepening the channels or using less draft. The measure of the damage is the cost of the least expensive of these methods. But we contend that no

material damage can follow the additional diversion requested.

On the other hand this diversion makes possible a great and inestimable addition to the navigation of the Great Lakes and connecting waters. Instead of injuring navigation, it adds a navigable belt around Chicago and the additional project provides what Captain Marshall in the U. S. Engineer's report 1890 states as follows:

'The terminal facilities as far as possible access to Lake Michigan is concerned of the Calumet river and connected chain of lakes for a large system of commodious docks and wharves and harbors (needing only deepening by dredging) in public waters of the United States, point irresistably to the Calumet region as the proper terminus of the proposed waterway from Lake Michigan to the Mississippi river.'

To all these additional facilities Canada will have access equally with the United States. This connection with the Gulf of Mexico leading directly to the Panama Canal will give interior America and Canada the full benefits of this great artery of trade opening in addition to the teeming population of the Mississippi valley the inestimable value to transportation and commerce of free access to the ports of the world.

In conclusion we urge that as against the alleged damage to navigation of a difference of three inches in water levels is offset the sanitation of our people and the construction of channels that without the sanitation feature would not be built, costing as they do upwards of seventy millions of dollars, but which when completed will give the objectors the benefits of the lakes to the gulf waterway and the Panama Canal, the two greatest waterway projects in the world, both of which built and paid for by the United States of America.

HENRY W. LEE, C. E.,
Consulting Engineer, Federation of South End Civic Bodies, Chicago, Illinois."

Resolution of Approval by the Federation of South End Civic Bodies, March 29, 1912

"Herewith I submit brief on behalf of the Federation of South End Civic Bodies of Chicago, Ill., in connection with the hearing before you relative to the permit requested by the

Sanitary District of Chicago to divert 10,000 cubic feet per second of water from Lake Michigan.

HENRY W. LEE, C. E.,
Consulting Engineer, Federation of South End Civic Bodies, Chicago, Ill."

"Whereas in the year of 1903 the General Assembly of Illinois passed an act enlarging the corporate limits of The Sanitary District of Chicago and providing for the drainage of a part of the added territory by said Sanitary District by means of a canal through the Sag Valley, and

Whereas the territory so annexed has been taxed for such purpose from that time until the present, and

Whereas thereafter the Internal Waterways Commission, composed of representatives of the governments of the United States and the Dominion of Canada, reported to the President of the United States recommending the terms of a treaty to be entered into between the two governments which proposed treaty contained a provision that The Sanitary District of Chicago be allowed to extract from Lake Michigan, for sanitary purposes, as much water as should be necessary, not to exceed ten thousand cubic feet per second, and

Whereas thereafter The Sanitary District of Chicago applied to the Secretary of War for a permit to reverse the flow of the Calumet river according to plans which provided for the diversion from Lake Michigan of fourteen thousand cubic feet of water per second, which application was on March 14, 1907, denied by the Secretary of War, and

Whereas The Sanitary District of Chicago, for the purpose of meeting the objections urged by the War Department, has since made further investigation of the problem of disposing of the sewage of the Calumet District, including the southern part of the City of Chicago, which investigation involved the expenditure of large sums of money, and as a result of such investigation the engineers engaged therein deem it absolutely necessary to reverse the flow of said Calumet River to prevent the pollution of Lake Michigan, but find it possible to effect said reversal of flow by diverting from Lake Michigan not more than ten thousand cubic feet per second, and

Whereas application was presented to the Secretary of War for a permit to carry on said work according to the opinions expressed by the War Department from time to time, which application was approved by Major Thos. H. Rees of the Corps of Engineers assigned to the District of Chicago, and

Whereas it is of vital importance to the health of the people of Chicago that this work be carried on without further delay, and

Whereas it has heretofore been held by the Judge Advocate General of the War Department that the Secretary of War has jurisdiction of the subject matter involved in the application for permit made by The Sanitary District of Chicago and the right to issue such permit, and the plans of The Sanitary District of Chicago have been approved by all the engineers having knowledge thereof and interested in the proper solution of the problems of sewage disposal in the City of Chicago and environs,

Now, Therefore, Be it resolved that the Secretary of War be, and he is hereby respectfully urged to grant said permit applied for by The Sanitary District of Chicago, and

Be It Further Resolved that the governor of Illinois, the Mayor of Chicago, the President of the Board of Commissioners of Cook County, Illinois, the Mayor of Blue Island, the United States Senators and each member of the House of Representatives of the United States Congress from Illinois are hereby respectfully requested to use their good offices for the securing of such permit."

Letter of Alfred Noble, Engineer, of New York City, April 2, 1912, to the Attorney of The Sanitary District and Presented to the Secretary of War March 30, 1912.

"You have requested me to express opinions on the following points:

1. Is it practicable to compensate for an increased diversion through the Drainage canal from 4,000 cubic feet of water per second to 10,000 cubic feet per second, by obstructions in the natural outlets of the Great Lakes so that the natural levels of the lakes may be maintained?

2. Assuming that the population of the Sanitary District will be 3,000,000 in 1920, and that the sewage from this population would be sufficiently diluted for sanitary purposes by a supply of 10,000 cubic feet per second, is it practicable to provide the works for the partial purification, as designed and estimated for by the Chief Engineer of the Sanitary District, in time to provide for the subsequent increase of population?

3. If the existing permit to divert water from Lake Michigan were revoked, would it be practicable to provide for the sewage satisfactorily?

In reply to your first question, I have to say that exact compensation, etc., effective at all points along the line of naviga-

tion, is probably impracticable, but I am decidedly of the opinion that substantial compensation, involving no material loss to any interests, navigation or other, is entirely feasible. The obstructions might be, for the most part, simple dikes or embankments, not expensive in character, supplemented in places by movable obstructions of no great extent. Such obstructions in the Niagara river would raise the levels of Lakes Erie, St. Clair, Huron and Michigan, and the St. Mary river below the falls, not precisely in the same proportion as the lowering resulting from the diversion, but closely enough for all practical purposes. It seems clear that the best results would be given by obstructions which would raise Lake Erie slightly above its natural level, with perhaps not quite full compensation in Huron and Michigan. Since the effect on any of these lakes of withdrawing the additional amount of water would be only about 4 inches, it seems probable that compensation could be effected to within an inch, by the obstruction suggested. Similar works at the principal rapids in the St. Lawrence river would maintain the natural levels of that river at all points above Montreal, and of Lake Ontario.

In reply to your second question, I am of the opinion that the constructions proposed can be provided as rapidly as required.

In case of the revocal of the existing permit, as contemplated by your third question, it would be necessary to discharge the sewage directly into the river and lake, which course experience has shown to be dangerous. The works necessary for the purification of the sewage to such a degree that the effluent discharged into the river and lake would be harmless would require several years to construct.

ALFRED NOBLE,
Consulting Engineer."

Letter of Approval by Federation of South End Civic Bodies, April 5, 1912.

"Kindly accept the enclosed as supplementary to my brief filed with you on behalf of the Sanitary District of Chicago. If necessary, it might be filed on behalf of the opposition, because of 'flooded Canadian lands,' the facts showing that the relative level of Lakes Ontario and Superior have changed in eight years since 1900 with higher relative level at Lake Ontario instead of lower, as alleged.

I have believed that you will welcome the facts and these are so simple and so conclusive, that it would be a breach of duty to neglect to send them.

HENRY W. LEE, C. E.,
Consulting Engineer, Federation of South End Civic Bodies, Chicago, Ill."

"The enclosed tables are from the report of the International Commission for 1910. The difference of levels between Superior and the other lakes below it are shown in parallel columns.

The average for eight years preceding and eight years following 1900, when Chicago drainage canal was opened shows variations of +.043, —.069 and +.107 for Michigan, Erie, and Ontario, respectively below Superior. This is not based upon estimate or guess or approximation, but upon actual facts, reports for sixteen years from the highest official sources, averaged for an equal period before and after the diversion at Chicago.

The results show that both Michigan and Ontario are relatively higher as regards Superior than before the diversion, although Erie is —.069, average for the second eight year period.

This proves that the mean average fluctuation is about an inch and that it is variable plus and minus, and that the difference is too small to be seriously considered in connection with navigation, other variations constantly off-setting and far overwhelming this negligible item.

The allegation of three or six inches or other change in levels is disproved by the facts and the records, the only true criterion."

MEAN WATER LEVELS.

	Sup. & Marquette Sup.	Milwaukee Mich.	below Sup.	Harbor Bend Huron	Cleveland Erie	Below Sup.	Oswego Ont.	Below Sup.
1892	601.51	580.88	21.13	580.38	572.14	29.37	245.38	356.13
1893	1.86	0.66	21.20	0.57	2.09	29.77	5.98	355.88
1894	2.56	0.78	21.68	0.76	.2.09	30.47	5.78	356.78
1895	2.62	579.74	22.88	579.83	1.17	31.45	4.29	358.33
1896	2.59	9.47	23.12	9.53	1.40	31.19	4.62	357.97
1897	2.00	580.13	22.47	580.13	1.96	30.64	4.80	357.80
1898	2.17	0.30	21.86	0.28	2.14	30.03	5.37	356.80
1899	2.69	0.32	22.37	0.29	1.91	30.78	5.20	357.49
1900	2.77	0.28	22.49	0.30	1.94	30.83	5.25	357.52
1901	2.75	0.54	22.21	0.57	1.30	31.36	5.06	357.69
1902	2.52	0.22	22.30	0.22	1.84	30.68	5.27	357.25
1903	2.73	0.31	22.41	0.36	2.38	30.35	5.87	356.86
1904	2.71	0.74	21.97	0.84	2.46	30.25	6.64	356.07
1905	2.74	0.88	21.86	0.95	2.17	30.57	6.21	356.53
1906	2.63	0.89	21.64	0.96	2.26	30.37	6.05	356.58
1907	2.51	1.02	21.49	1.05	2.73	29.78	6.66	355.85
					Erie Below Sup.		Ont. Below Sup.	
						30.455		357.148
Mich. below Sup.								
1892-99				22.069				
1900-07				22.046		30.524		357.041
				+ .043		— .069		.107

Letter of Approval by David R. Forgan, Pres. Nat. City Bank of Chicago, to Pres. Taft, May 1, 1912.

"I have been asked to call your personal attention to a matter of importance to the City of Chicago in which the Association of Commerce is deeply interested.

The Sanitary District has made application to the Secretary of War to be allowed an increased flow from Lake Michigan from 4,167 cubic feet per second to 10,000 cubic feet per second. The Secretary of War has had a hearing in which the Sanitary District, navigation interests, and the Dominion of Canada have all been represented. The briefs in the case have been referred by the Secretary of War to General Bixby for analysis and report.

Now, to put the matter plainly, the members of the Association of Commerce who are in charge of this matter are afraid that the inclination of General Bixby, and also of the Secretary of War, will be simply to view the whole matter from the standpoint of navigation, and not give due weight to the consideration of the vital question for Chicago of its sanitation, and they wish me to request of you that, if pos-

sible, you give the matter some personal, or cabinet consideration when the proper time comes.

This I respectfully ask you to do in the interests of fairness in a rather complicated matter.

David R. Forgan,
President."

Letter of Approval by John V. Farwell to Pres. Taft, May 8, 1912.

"The Association of Commerce of Chicago whose public spirited work in this city and elsewhere I am sure you are familiar with, through Mr. Wheeler and others who are well known to you, has been deeply interested in the question of increased flow of water from Lake Michigan into the Sanitary District Canal.

Application, as I understand it, is now before the Secretary of War, to allow the District to increase the flow from 4,167 cubic feet per second to 10,000 cubic feet per second.

The Dominion of Canada and some shipping interests have been against this increase, whereas, nearly all Chicago interests are in favor of it.

Believing it to be a case to be viewed not only from the standpoint of navigation but from that much more important one, the health of millions of people living in Chicago and along the line of the Canal, the Association of Commerce were in hopes that you might be able to give the matter some personal attention, or have it brought before the Cabinet for thorough consideration before final decision is reached.

From what I can make out the Sanitary District was not very well represented by the best obtainable legal counsel in making arguments before the Secretary of War.

John V. Farwell,
President."

Letter of Approval by Secretary of the Treasury Franklin McVeagh to Secretary Stimson, May 27, 1912.

"Ever since the Cabinet meeting when Secretary Fisher urged upon your attention the deep interest of Chicago in the question of water for its drainage system, I have felt that I did not sufficiently accent my approval of the urgent representations which the Secretary of the Interior then made.

And at this rather late day I want to make it perfectly clear to you that I am profoundly impressed by the vital interest which Chicago has in your decision. It may well be that the present drainage system cannot be permanent; but a claim to that effect is recent. We started in with the full expectation that we had a permanent method of drainage, wholesome and unobjectionable from every point of view. It is only later that questions have been raised which seem to point to the necessity of another system of sewage disposal. But, Mr. Secretary, that is a tremendous engineering job and an exceeding financial job. And there are great complications which make obstacles of a most serious nature to any change of system. And, therefore, it must take time to do this—if it is ascertained that it must be done eventually. It is not easy for Chicago to raise sixty millions of dollars or a hundred millions, as this may require. We have spent sixty millions on that drainage canal. Of course, we can throw that away. But it is a serious thing to throw sixty millions away. And it is another very serious thing to raise sixty or a hundred millions, because the Constitution of Illinois restricts, in the most rigid manner, the bonded indebtedness of municipalities. Altogether this is not purely an engineering question you have to decide now; but it is an economic question. And it is a question of what is fair and just to a city of great size and importance, which is the second city in the country. We are a long way from you and you are a long way from us when you are in New York or in Washington. And we have, therefore, to make our appeal under certain disadvantages to an Eastern man. It is much easier for almost any Eastern man to understand an eastern city than to understand a western city. Moreover, Chicago doesn't have the popular appeal in the East that it has in the West. But to me the appeal of the real interests of Chicago is always most impressive. Chicago never plays the baby act; and it doesn't ask for sympathy. It is a manly municipality, and self-reliant. But it has the great interests of not only itself but of the Middle West in its keeping. And dealing with it is dealing with a very great body of public interests.

Now, if we must change our drainage system give us a chance to do it without, in the meantime, suffering. Of course, if the United States Government had said in the beginning that this drainage system was a temporary expedient we would never have entered upon it; and if now it is but a temporary expedient, then I think we should be patient with it

and give it time to change itself, meanwhile treating it generously so that the city can live throughout the interval healthily and safely.

I am appealing, of course, for my home. And I don't want to deny that. But it seems to me I am appealing rather for a great metropolis that happens to be dependent upon your decision.

FRANKLIN MACVEIGH."

Statement of Lawrence McCann, of Chicago, to Secretary of War Stimson, February 28, 1912.

"Mr. Secretary, I would simply ask that since the city of Chicago is referred to as a corporation, for its people I want to beg of the Secretary and the citizens representing other sections of the country, to understand that in the evolution of a great city and in the development of navigation certain things have arisen which may appear to conflict. But the citizens of Chicago would not perimt for one moment that they should appear to tolerate an evasion of any improvement or of any economy that may be developed; and neither the citizens of Chicago nor the corporation of Chicago through its properly accredited officers will yield in their zeal and in their determination to maintain the highest efficiency for navigation consistent with the preservation of conditions of health and safety in the city of Chicago.

I simply beg of you, Mr. Secretary, to keep in mind that the city of Chicago is made up of honorable people, and that many of the questions submitted today are not creditable, and insinuating that there may be an ulterior purpose and motive. There are none but the purest motives, the motives that inspire men and citizens to maintain pure homes, preserve life, promote health and happiness, and in the consideration of this question I want to beg in the name of the Mayor of Chicago, whom I am here to represent, and the people of the city of Chicago, as distinguished from the Sanitary District, that the question be given the simple and fair consideration which I know the Secretary will give it, and I beg for the Commission of the city of Chicago, that it be permitted to file a brief on this question, for the corporation of Chicago, treating the question of navigation, the question of good faith with the Government in carrying out of every regulation that has been laid down by the Government. As you will remember, Mr. Secretary, I have communicated with you, some months past,

in regard to this matter. These will be carried out in absolute good faith through your representatives and through yourself, and the city will take pleasure in co-operating and carrying out the law. But the city also asks that we be given every consideration in the protection of the health of the citizens of Chicago, until such time as a system may be adopted for sewage treatment as will be acceptable and a fair system, and especially considering that the people of Chicago have spent this great sum of money during a period when it was regarded as the most advanced method of treating sewage, when there were no protests and when it was believed that every step, every effort, and every expenditure was being made with the knowledge, the consent and the approval of the Federal authorities.

I simply ask permission in the name of Chicago to file a brief."

Statement on Behalf of the City of Chicago by Lyman E. Cooley, Consulting Engineer, Mar. 30, 1912.

"On the application of the Sanitary District of Chicago, for a permit to increase the flow into its main channel or outlet by way of the Chicago River and other feeders, and in the hearings relating thereto, the City of Chicago has been represented by the Commissioner of Public Works, Hon. Lawrence E. McGann, acting for the mayor, and by Aldermen Charles E. Reading, L. D. Sitts, W. F. Ryan, and John S. Derpa, acting for the city council, and by their consulting engineer, Lyman E. Cooley.

The City of Chicago, has been and is co-operating with the Sanitary District and supporting its contentions, and it has the most vital concern in the issues before you. The consideration of the subject matter has taken a very wide range and raised many questions, all of which could not be anticipated, and the city feels that it should submit a brief in its own behalf which would go fully into the mreits of the questions involved. But it seems that time cannot be allowed for this purpose. The representatives of the city therefore feel constrained to limit themselves to a statement which shall recite concisely the history of the matter, the position of the city, and re-enforce the position of the Sanitary District of Chicago, and the undersigned has been authorized and directed to prepare and submit such statement.

1. The Sanitary project was matured by the City of Chi-

cago in the years 1885-9 at a cost of about $100,000, under the advice of engineering and legal experts and with the co-operation of the State Board of Health of Illinois and a joint committee of the General Assembly. The city promoted the Sanitary District Act in force July 1 1889, and continued its oversight until the Sanitary District was adopted by the people and actually organized early in 1890. The purpose was to provide a main channel or outlet with necessary adjuncts by which the City, together with other municipalities within the corporate limits of the District, could dispose their sewage under certain conditions as laid down in the organic law. Since its organization the confines of the Sanitary District have been enlarged and the City of Chicago through annexation has absorbed in large part the urban population and now contains 94.5 per cent. of the population of the Sanitary District.

The City of Chicago is endowed with full municipal functions as a part of the political system of the state and could have undertaken the complete solution of the sanitary problem had it possessed the proper territorial limits and the necessary financial resources. The Sanitary District was therefore created for a limited and specific purpose. The city therefore views with the gravest concern any proposition or action which tends to limit or disbar any function or power of the Sanitary District because the burden will thus be shifted in greater or less degree, or wholly, back upon the city, with extraordinary complication and cost beyond the power of the city to meet.

The entire policy of the city and its environs for the past twenty-five years in respect to the sewage system, the park system, the harbor and waterway development and all collateral work, has shaped itself in conformity with the sanitary and ship canal project, and any attempt to change policies and conditions at this time will result in the utmost confusion and cannot be seriously entertained or admitted by our people.

2. The Sanitary and Ship Canal of Chicago was actually constructed across the Chicago Divide between the waters of the Chicago River at Robey street and the Desplaines River at Lockport, with a flowing capacity of 840,000 cubic feet of water per minute, or 14,000 cubic feet per second in round numbers at low water of 1847 in Lake Michigan. A small portion of this channel in the clay between Robey street and Summit was constructed with a preliminary capacity of more than 500,000 cubic feet of water per minute, and under the

law is subject to progressive development with the growth of population and also to complete development within one year after the General Government shall co-operate in the production of a through waterway. The cost of such development is relatively a small item. The channel was actually opened January 17, 1900, in compliance with Section 27 of the organic law and no change affecting the capacity thereof has since been made.

The City of Chicago does not admit any doubt as to the full right and power of the State of Illinois to authorize the particular solution and the method of applying it as outlined in the organic law, and attention is called to the decision of the U. S. Supreme Court in 1906, in the case of State of Missouri v. The State of Illinois and the Sanitary District of Chicago, where the whole subject matter was entered into and affirmatively decided. It is not now competent to raise questions as to the manner of the solution nor in regard to the right to take water to the extent of the capacity of the main channel or outlet, or 14,000 cubic feet of water per second at low water of Lake Michigan.

Under the authority of the state, the Sanitary District proceeded diligently and completed its channel as above stated, and had actually notified the Governor of that fact, before the end of the year 1898, and several months prior to the Act of Congress of March 3, 1899, Section 10 of which has been assumed to give jurisdiction in the premises. The permit issued by the Secretary of War and the Chief of Engineers, U. S. Army, May 8, 1899, does not bear out any such presumption, but is conditioned solely by the capacity of the Chicago River. In no event could the act cited have a retroactive effect.

The right of the United States to conserve the highways of commerce and the easements which it has developed is not questioned, and we assume that the right to take water cannot be exercised in a wilful and frivolous manner and so as to create unnecessary hardship to other interests, and therefore we admit a certain degree of supervision as to the manner in which the water shall be taken. The law of the State of Illinois also states that public waters shall not be entered upon and utilized in such manner as to unduly interfere with their uses for navigation.

In addition to the foregoing Chicago claims a right to 1,000 cubic feet per second by way of the Illinois and Michigan Canal and that such right is both proscriptive and by authority of law.

In view of the circumstances already stated the city is unable to develop properly and fully its contentions respecting the foregoing and it expressly reserves its rights in case they are not admitted.

3. The expenditures by the Sanitary District of Chicago from its organization down to January 1, 1912, have been	$68,524,491.16
The expenditures by the City of Chicago for its intercepting sewer system along the lake front of the city have been	6,706,804.37
The total is	$75,231,295.53

The same ratio of expenditure extended over the United States would represent about $3,000,000,000, or several times the amount expended by the United States upon its river and harbor system.

The further amounts that must be expended in developing and completing the program will bring the total well above $100,000,000. In addition the park boards have expended large sums and will expend still larger sums in parkways along the city front, which serve to protect the water supply of the city and to transfer the filth producing industries to the back lots. It is further recognized that the large sums required for harbor and waterway development must conform to the adopted program.

4. The waterway policy of the State of Illinois has been established from the beginning. The Sanitary District Act was intended by its promoters as primarily a health provision and an important consideration in its passage was that the same waters that performed the service for Chicago would perform a like service for all the urban population contiguous to the Desplaines and Illinois Rivers. A secondary motive was the contribution which would thus be made to the waterway policy of the state; and the state took good care that these provisions of law should be fully set forth. And from the standpoint of the state the Sanitary District Act is a waterway act in which Chicago is allowed certain rights of sewage disposal, in consideration of its investment. The state further defines its position by contemporaneous act and joint resolution and has since adopted a constitutional amendment by which the General Assembly is authorized to expend $20,000,000 between the end of the drainage canal and the head of the lower Illinois River at Utica for waterway

development and incidental water power. The state policy in this respect is based on the full capacity of the drainage canal or 14,000 cubic feet plus the capacity of the Illinois and Michigan Canal, or 1,000 feet, a total of 15,000 feet. The state recognized that a large volume of water will enable the production of a deep waterway not less than 14, feet, as stated in the joint resolutions of 1889 and 1897, and it is further recognized in the report of 1907, that the larger volume for which the Sanitary Canal was actually constructed will enable a still greater depth through the lower Illinois River.

5. The Association of Drainage and Levee Districts of the State of Illinois represents the lands subject to reclamation in the lower Illinois Valley, some 400,000 acres, and it recognizes the necessity for a deep and capacious channel, with a large and permanent water supply therein for the stability and maintenance of the lower Illinois River as well as for the sanitary welfare of the valley; and they are promoting the removal of the dams in this portion of the river and the development of such channel by dredging in conjunction with the water supply from Lake Michigan for the threefold object of drainage, sanitation and deep navigation.

The Lakes-to-the-Gulf Deep Waterway Association represents all interests in the several states bordering the route between Lake Michigan and the Gulf of Mexico, and this association has adopted a policy as set forth in its last two conventions, 1910 and 1911, for a waterway with a preliminary depth of 14 feet with all structures and rock cuts adapted to an ultimate depth of 24 feet, and the large water supply provided for by the State of Illinois is necessary to the carrying out of such a policy.

6. The water power development by the Sanitary District and by the State of Illinois comes strictly under the rules laid down by the U. S. Supreme Court in the Montello case. The Supreme Court of Illinois held in the case of the suit to test the validity of the Sanitary District Act, in June, 1900, that it would be unreasonable to deny the right to develop water power which was created by other than necessary work, and called attention to the fact that the burden of taxation might thus be mitigated. Under the project of the Deep Waterway Association eighty per cent. of the fall between Lake Michigan and the Mississippi River at Cairo, may be converted into water power and this amounts to about half of what the same water would produce if utilized for the same

purpose in the direction of the St. Lawrence, and not one-fourth as has been stated.*

There can be no objection to the development of such power under public ownership as proposed, and as the incident of other and necessary uses of the water for sanitary and deep waterway purposes. It is a circumstance not to be overlooked that the waters diverted are to be put to all of the three uses recognized in their order in the recent treaty respecting the boundary waters between the United States and Canada, to wit: domestic and sanitary, waterway, and water power. These uses are not alternative but cumulative, and they combine in a justification superior to any separate and distinctive reason.

7. The population of the Sanitary District, by the Federal Census of 1910 was 2,311,810. The contiguous population within ten miles of the water route between the Sanitary District and the Mississippi River was 445,828. The total population in the District and in the valley immediately concerned in the sanitary problem and also in the deep waterway was 2,757,638. Of this population 2,468,450 were urban or in communities of 2,500 people and upwards. The aggregate represents 49 per cent. of the total population of the state and 71 per cent. of the urban population.

The aggregate population in cities of 25,000 and upwards about the Great Lakes above Niagara in 1910 was 2,325,543, or less than the urban population of the Sanitary District and adjacent to the water route in the State of Illinois. The statistics for the minor cities are not yet available and these would increase the aggregate for the lakes. And again, we should add the urban population on the Canadian side, for which the data are not in hand. The total, however, would not greatly exceed the figures given for Illinois. There are other populations in the United States and Canada below Niagara which claim to be affected by the diversion of waters and again there are other populations in the United States below the mouth of the Illinois which are benefited thereby.

It may be said, therefore, that a population nearly if not substantially equal to that outside of Chicago and bordering the Great Lakes above Niagara have an indentical interest in the maintenance of all conditions which favor navigation.

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*NOTE: This statement is based on complete development and full utilization by means of dams. Reserving the scenic attractions of Niagara River under the Treaty of 1909 and employing the usual methods of development, the statement in Topic 51 is also true.

It may be said further that such population have a deep and immediate concern in the development of a deep waterway through the State of Illinois and onward to the Gulf of Mexico, and that that deep interest should in truth extend to all the population about the Great Lakes and differ only perhaps in degree. In addition to the above this half of the total has a paramount interest in its life and health, which should be generously recognized by the other half even though minor damage and inconvenience be inflicted. If it is shown later that no actual harm or inconvenience is necessary, then most certainly there can be no valid ground for objection, in view of the tremendous potentialities involved in the diverted water.

8. The effect on lake levels and the damage caused thereby is likely to be overestimated. Causes affecting lake levels are many and show up in continual oscillation, sometimes through a considerable range, and in changes of general level with the seasons in the years, and through a cycle of years. There are no fixed rules to govern the variable effects due to difference in rainfall, vegetal cover, run-off and evaporation, and the individual and collective effects are so incapable of precise definition that it is impossible to deduce a remainder which could be assigned to an unknown cause. The fact of a diversion and the amount thereof would be discoverable only in the new outlet itself, and the valuation of the effects thereof would be purely a deduction from physical data and not a subject of direct observation. Whatever the effect may be, by such amount is lowered the general horizon of oscillation and change. Owing to the variations vessels cannot utilize the depth with the same degree of certainty as though a fixed and invariable plan prevailed, and it may be questioned whether a proper rule of damage can be based on the theory of a change in such plan. In other words, is it not attempted to apply the precision of the rifle to a shotgun problem?

It is to be noted that the natural depths at characteristic localities in the intermediate channels of the lakes were originally from ten to twelve feet and that these depths were increased at various times until a general depth of sixteen feet prevailed, and that between the years 1891 and 1895-6 these channels were deepened by four to five feet and greatly enlarged, and that coincident with the completion of these deeper channels we have the characteristic low water period. It is to be noted further that following the high water of 1886

there has been almost a continuous deficiency in rainfall, amounting to six feet more or less at various lake stations, and this coupled with accentuation of evaporation has produced profound results. It is to be noted also that the Board of Engineers on Deep Waterways, in its report of 1900, recognizes a permanent lowering of Lakes Michigan and Huron by nearly one foot, through a change in the outlet at Port Huron. It may be said further that the report of the International Waterways Commission for 1910 calls attention to the fact that the level of Lake Superior was unwittingly controlled for a number of years by the works of the International Bridge and of the water power companies at Sault Ste. Marie, with consequent influences on the levels of the lakes below, and this fact, though the effects were comparable with those assigned to the Chicago Drainage Canal, seems to have attracted no attention. These several and superior effects seem to have aroused no excitement among vessel interests, nor have they led to any propositions for remedying the same. It is therefore not quite understandable why such supreme importance is attached to the minor effects produced by the diversion at Chicago. The report of the First International Waterways Commission, 1896 (American section, known as "United States Deep Waterways Commission"), gives all obtainable information respecting lake levels prior to 1860, and it appears that the highest water known occurred in 1838, and that the lowest water known occurred nineteen years previously, in 1819-20, and that such low water was from eight inches to one foot lower than the low water of 1895-6. It appears, therefore, that the extreme fluctuation of the lake surface took place within a period of nineteen years, and before inhabitation had changed conditions in the watershed, and before lake channels had been disturbed. The range of fluctuation in Lake Michigan was between six and seven feet.

Had the Chicago diversion begun in 1895-6, contemporaneously with the opening of the deeper intermediate channels and the Poe Lock at the Soo, and when the lake fleet had not developed to these greater depths, it could not have been said that navigation interests were damaged by reason of the fact that the unutilized depths had been diminished by a number of inches. On the contrary, it is known that great loss in vessel property took place as soon as the larger depths were utilized by the greater carriers, and that such damages were without redress because what had been done was in the interest of the common welfare. The new lock at the

Soo authorized some time since and now under construction is to have a depth of 24½ feet, the same as that of the Drainage Canal, or several feet in excess of existing channels, and the policy of producing channels which shall equal such lock depth is already established. In view of this project actually in sight and in process of consummation, is it to be said that vessel interests will be damaged by a diminution in depth not yet utilized and for which no vessel exists? In the progressive deepening of lake channels and that of the harbors which must follow is not the effect of diversion substantially met, and, if not, does it involve more than a nominal increase in cost to meet the deficiency due to such cause?

9. A minor damage or inconvenience may be without redress under the doctrine of "comity among utilities," but that is no sufficient reason for denying the appropriation of public waters to beneficial use when and where the benefits are manifold and contribute in an extraordinary degree to the public welfare. The report of the International Waterways Commission, on the Chicago Drainage Canal, 1907, estimates the damage to be occasioned by the diversion of 10,000 cubic feet per second and the consequent lowering of the lakes by six inches at $1,500,000 per annum, in round numbers. On the other hand, the value from the bettered sanitary condition at Chicago and in the Illinois Valley cannot be estimated in figures; the value of the water highway that is to be produced with the aid of this diverted water is comparable with that of the Great Lakes; the reclamation of the overflow lands of the Illinois Valley is facilitated, and this represents a very large sum; water powers are created under public ownership, and this represents another large contribution to wealth; and again fisheries develop through the greater volume and the enrichment of the waters.

In the ten years between 1896 and 1906, the fisheries of the Illinois River increased from a catch of about 8,000,000 pounds to 22,000,000 pounds and the stream was second to the Columbia, where in fact the fish are the product of the sea. The value of these fish on the shore of the waters was over $770,000, or $11 per acre for all the water space in the Illinois Valley, and this value was doubled by the time the fish reached the consumer or exceeded $1,500,000, and will grow exceedingly with the fuller development of the Chicago program. In other words, the value of the annual fish crop which has come to pass through the carrying out of this en-

terprise exceeds all the damage which it is claimed has been occasioned to the shipping interests on the Great Lakes.

10. A remedy that may be applied so as to conserve the actual uses of water now made and avoid all damage is a complete answer to any objection to the taking of any volume of water that can be applied to other beneficial uses. No one will contend that waters cannot be appropriated if other and prior appropriations and dedications are not unduly interfered with.

The International Waterways Commission has examined a number of remedies, one of which is that of deepening channels and harbors by one foot at a cost of $12,500,000, which would allow the taking of 20,000 cubic feet of water per second, or a third more than the capacity provided for in the channels at Chicago. It is submitted that this cost would be still less if the deepening is part of the program for deeper channels and harbors now initiated by the construction of the new lock at the Soo.

The International Waterways Commission, in its report for 1910, suggests a remedy which it regards as better and sufficient by means of compensation work. It is now engaged in working out the problem connected therewith, and is to report thereon before closing its labor.

It is unnnecessary to multiply instances or advance suggestions. Congress has authorized examinations and reports respecting the better control of lake levels and has also authorized examinations and reports based on the theory of utilizing waters diverted from Lake Michigan.

The State of Illinois directly and through its agencies has made a very large expenditure and is prepared to make other very large expenditures, the effect of which will be to produce a great waterway which will pass to the control of the General Government, under all state laws thus far made and proposed, and the United States will thus be relieved of cost many times exceeding the cost of any remedies that may be required on account of diverted waters. It is felt, therefore, that the United States should raise no question of liability as against the State of Illinois and its agencies on matters beyond their jurisdiction.

11. The international question and the bearing thereon of the treaty of 1909 respecting boundary waters between the United States and Canada will not be entered into at this time. Attention, however, is called to an opinion furnished to the State Department by the Attorney General, Judson Harmon (see Opinions of Attorney Generals, 1895-7), in re-

gard to a boundary water of the United States and Mexico, the Rio Grande del Norte, the navigation of which is expressly guarded by specific terms in the treaty of Guadloupe Hidalgo, between the United States and Mexico. In this case the waters of the stream were consumed in the development of the State of Colorado and the Territory of New Mexico, and in the opinion the rules of international law applicable in such cases are fully set forth.

It appears that the right of the people of a State to develop their resources and opportunities is fundamental, and that the United States cannot qualify by treaty sovereign rights not possessed by it.

12. In conclusion it may be recapitulated:

(a) Under proper and sufficient authority, physically expressed in adequate channels actually constructed and in existence, the right is established to take 15,000 cubic feet of water per second from the Chicago River by way of the main drainage channel or outlet and by way of the Illinois and Michigan Canal.

(b) The Secretary of War and Chief of Engineers, U. S. A., may not impair this right, but shall regulate the manner of taking so that no undue injury shall occur to the navigable channels through which such waters shall pass, as heretofore contrued in permits.

(c) Independent of the questions referred to above under (a) and (b) the right to take the water should not be questioned in view of the enormous expenditures already made, the policies established and the expenditures predicated thereon, and in view of great and manifold benefits as contrasted to minor damage and inconvenience.

(d) Such minor damage as may occur is not irreparable and may be remedied at comparatively small cost, and the taking of waters for beneficial uses under such circumstances is not a subject for objection.

(e) The remedy, if any, is not within the jurisdiction of the State of Illinois and should be applied by the United States in view of the tremendous contribution of the State of Illinois and its agencies to a waterway of national and international importance.

(f) All the points herein referred to can be set forth and established in a brief in full which the time available has not permitted.

On behalf of and for the City of Chicago.

(Signed) Lyman E. Cooley,
Consulting Engineer."

United States of America,
vs.
Sanitary District of Chicago. }

Proceedings in the above entitled cause before the Commissioner, on December 16, 1914.

Mr. Wilkerson: On behalf of the Complainant I desire to submit to the Commissioner and offer in evidence further documentary proof pursuant to the terms of the stipulation of the parties herein signed on November 16, 1914, as follows:

"UNITED STATES OF AMERICA

War Department.

Washington, October 28, 1914.

I hereby certify that the papers hereto attached are true copies of papers on file in this office, described as follows:

'Draft for a permit * * * respectfully submitted to the Secretary of War by the Sanitary District of Chicago for a formal permit to open the channel, the Sanitary District of Chicago by B. A. Eckart, one of the Trustees. (E. D. 28918/7.)

The Sanitary District of Chicago, letter of Alexander J. Jones, President, to Secretary of War, July 15, 1901. (E. D. 35242/67.)

The Sanitary District of Chicago, letter of Board of Trustees, to the Secretary of War, October 16, 1901. (E. D. 35242/69.)

The Sanitary District of Chicago, letter of William H. Baker, Vice President, to Major J. H. Willard, October 16, 1901. (E. D. 35242/70.)

The Sanitary District of Chicago, letter of Board of Trustees to the Secretary of War, October 24, 1901. (E. D. 35242/72.)

The Sanitary District of Chicago, letter of Thomas A. Smyth, et al., to the Secretary of War, December 29, 1902. (E. D. 35242/78.)

The Sanitary District of Chicago, letter of Robert R. McCormick, President, to Colonel W. H. Bixby, November 28, 1906. (E. D. 28918/57.)

The Sanitary District of Chicago, letter of Isham Randolph, Chief Engineer, to W. H. Bixby, December 3, 1906. (E. D. 28918/67.)

'G. Form of War Department permit desired by Sanitary District of Chicago * * *'. (E. D. 28918/65.)

The Calumet-Sag Channel. The Project. (E. D. 28918/60.)

Argument for reversing the flow of the Calumet River. (E. D. 28918/63.)

The Sanitary District of Chicago, letter of G. M. Wisner, Chief Engineer, to the Secretary of War, September 2nd, 1907. (E. D. 64900.)

'September, 1907. Sanitary District of Chicago. Plan of location of proposed North Shore Drainage Channel between Lake Michigan and North Branch of Chicago River' * * *. (E. D. 64900/1.)

(Signed) DAN C. KINGMAN.

I hereby certify that Dan C. Kingman, Chief of Engineers, U. S. Army, who signed the foregoing certificate, is the Chief of Engineers, U. S. Army, and that to his certification as such full faith and credit are and ought to be given.

In testimony whereof I, Lindley M. Garrison, Secretary of War, have hereunto caused the seal of the War Department to be affixed and my name to be subscribed by the Acting Assistant and Chief Clerk of the said Department, at the City of Washington, this 29th day of October, 1914.

(Signed) LINDLEY M. GARRISON,
Secretary of War.
By JOS. RANDOLPH,
(Seal) *Acting Assistant and Chief Clerk."*

Whereas, the Sanitary District of Chicago, a municipal corporation duly organized by an Act of the General Assembly of the State of Illinois, approved May 29, 1889, in force July 1, 1889, and Acts amendatory thereof has proceeded under said Acts and the amendments thereto to construct a channel of a capacity capable of flowing 300,000 cubic feet per minute at a velocity of one and one-quarter miles per hours, and,

Whereas, the said channel connects with the West Fork of the South Branch of the Chicago River at Robey Street in the City of Chicago; and,

Whereas, under the powers conferred by the aforesaid Acts the said District prepared plans for deepening the West Fork of the Chicago River and the South Branch thereof throughout the entire length from Adams Street in the City of Chicago to Robey Street, so as to secure a depth of twenty feet, and,

Whereas, the said plans provided for widening the said river at sundry contracted points to secure the requisite volume of flow without undue acceleration of current and in those

places where widening was not possible the plans provided for the construction of by-passes or covered waterways, and in two instances for the removal of center pier bridges and the substitution of bridges of the bascule type without central supports; and,

Whereas, the general plans for this improvement were duly submitted to the Secretary of War in 1896 and by him approved in a certain communication dated July 3, 1896, said approval being subject to limitations therein set forth among which was the requirement that plans in detail for the several parts of the work should be submitted to the War Department for approval before any work should be done thereunder; and,

Whereas, in compliance with this requirement of the said approval of July 3, 1896, the Sanitary District has submitted to this Department plans for certain by-passes, cofferdams and bridge structures which have, from time to time, received the approval of the Secretary of War, as set forth in permits issued by him under the following dates: November 16, 1897; November 30, 1898; January 13, 1899, and March 10, 1899; and,

Whereas, the said District has proceeded under these several approvals and permits to perform the work shown upon the plans; and,

Whereas, the entire main channel of the said District and the work in the Chicago and Des Plaines Rivers is now rapidly approaching completion according to said plans; and

Whereas, it is necessary under the Act of Congress of September 19, 1897, that authority shall issue from the War Department under which the said Sanitary District may cause the waters of the Chicago River to flow to the west into the main channel of the said District; and,

Whereas, the widening and deepening, already accomplished, and as further projected by the Sanitary District is a betterment to navigation in the Chicago River; and,

Whereas, it has been shown by them that they have constructed such movable dams and sluice gates as will at all times secure absolute and complete control of the volume and velocity of flow through the main channel of said District and consequently through the Chicago River;

Now Therefore, by virtue of the authority vested in me by the laws of the United States I hereby authorize said Sanitary District of Chicago to open the channel constructed by it so soon as it shall have completed all of the work outlined by it in the Chicago River.

Said document has the following endorsement:

"Respectfully submitted to the Secretary of War by the Sanitary District of Chicago for a formal permit to open the channel.

The Sanitary District of Chicago, by B. A. Eckart, one of the Trustees."

Letter Head of
The Sanitary District of Chicago

Chief Clerk
Jul
17
1901

Chicago, July 15, 1901.

War Dep't.
Rec'd
Jul 17 1901
Office Secretary of War.

"To the Honorable Elihu B. Root,
Secretary of War,
Washington, D. C.

Sir:

I have the honor to request on behalf of the Sanitary District of Chicago that your order of April 9, 1901, restricting the flow of water through the Chicago River to 200,000 cubic feet of water per minute, may be so amended as to permit the Controlling Works at Lockport, the outlet of the main drainage channel, to be so regulated as to permit at that point a flow of 300,000 cubic feet of water per minute, between the hours of 4:00 P. M. and 12:00 o'clock midnight.

The Board of Trustees of the Sanitary District have rigidly observed the restrictions of your order of April 9th, 1901, but the result has been that the water in the Main Drainage Channel has become greatly polluted and very offensive both to sight and smell and is working such hardship upon the valley communities as to evoke frequent protest from various cities and municipalities along the Des Plaines and Illinois Valleys.

By such a modification of your restricting order as is herein petitioned, it would be possible for the Sanitary District to secure much better drainage of the City of Chicago and the purification of the waters of the Chicago River without any hardship or inconvenience whatever to the interests of navigation; as the opening of the controlling works to a flow of 300,000 cubic feet of water per minute would produce no appreciable effect upon the current of the Chicago River until three hours thereafter and would not produce the full effect until about eight hours after the opening of the gates. Therefore, by again diminishing the flow at midnight to the requirements of your order, or to 200,000 cubic feet of water per minute, the normal condition in the Chicago River would be restored before six A. M. on the following day and thus no hard-

ship or inconvenience occasioned to the navigation interests of the Chicago River.

I have the honor to be, very respectfully yours,

(Signed) ALEXANDER J. JONES,
President."

The above document has the following endorsement:

The Secretary.
60 of 1900
—
37 1901
War Department

Office Chief of Engineers.
35242
Jul 18 35242
—
67 1901
War Department.

Chicago, Illinois, July 15, 1901.

Sanitary District of Chicago,
Alexander J. Jones, President.

Request that the restriction of April 9, 1901, regulating the flow of water through the Chicago River to 200,000 cubic feet per minute, may be amended to permit a flow of 300,000 cubic feet per minute between the hours 4 P. M. and twelve o'clock midnight.

Noted—Map Files.

Recd. Back. Office Chief of Engineers, July 26, 1901.
File 55, 65, 66, 68, accp.
Recd. Back. Office Chief of Engineers, July 25, 1901.
File 55, 65, 66, and ps accomp.

(Second endorsement.)
Office Chief of Engineers
U. S. Army.

July 22, 1901.

Respectfully returned to the Secretary of War.

By an instrument dated April 9, 1901, the Secretary of War directed the Sanitary District of Chicago to regulate the discharge from the Chicago River into the Drainage Canal so that the maximum flow through the Chicago River and its South Branch shall not exceed 200,000 feet per minute.

The Sanitary District now asks that this order be so amended as to permit an increase of the flow into the canal to 300,000 cubic feet per minute between 4 P. M. and 12 midnight, daily.

It is the opinion of Major Willard, expressed in the accompanying letter of the 16th inst., that the request should be

granted subject to revocation by the Secretary of War in case the increase be found dangerous to navigation.

I concur in this opinion and recommend that the order of April 9, 1901, be modified accordingly.

G. L. GILLESPIE,
Brig. Gen. Chief of Engineers,
U. S. Army.

35242
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67
Inclos. 55, 65, 66, accompan'g (Chief Clerk July 22, 1901. War. Dep't.)

Rec'd
Back Jul 22, 1901 Record Div. War Dep't.

Chief Clerk.

(Third Endorsement.)
War Department.
July 23, 1901.

Approved as recommended by the Chief of Engineers.

E. ROOT,
Secretary of War.

Rec'd Jul 25, 1901 Record Div.
back War Dep't.

Chief of Engineers.

Rec'd Office Chief of Engineers. Jul 25, 1901.
Rec'd Record Div.
Back Jul 25, 1901. War Dep't."

Letter Head of
The Sanitary District of Chicago.

Chief Clerk
Oct 19 1901
War Department.

Chicago, October 16, 1901.

Received
Oct 19 1901
Office
Secretary of War.

Hon. Elihu Root,
Secretary of War of the United States,
Washington, D. C.

Dear Sir:

The undersigned respectfully petition you as Secretary of War to give us permission for an increased flow in the Chicago River, over the 200,000 cubic feet a minute, now in force by your order of July 23, 1901. We, the petitioners, inasmuch as a number of very material improvements have been made in the Chicago River, such as removing center pier bridges,

widening the river at many points, and also deepening the same, thereby allowing a much greater flow without any perceptible increase in velocity of the current, believe that we are full justified in petitioning you to grant to the Board of Trustees of the Sanitary District of Chicago permission to increase the flow from 200,000 to 250,000 cubic feet per minute, during that period of the day allowing a flow of 200,000 cubic feet per minute.

Below we enumerate the following improvements:

The old Randolph Street center pier bridge is now removed, and all obstructions which hindered navigation will be out of the way in but a few weeks, and a bascule type, with a 140-foot opening, will be erected, similar to that on Taylor Street.

The old Harrison Street center pier bridge is removed, and a new bascule type bridge with 140-foot opening, with by-passes on each side, is being erected instead.

At Taylor Street the new bascule bridge is in operation, which has a clear opening of 120 feet.

The new bascule bridge of the Chicago Terminal Transfer Railway Company is about ready to be operated, and the old center pier bridge will immediately be removed.

Just north of 12th Street the river has been widened, by the cutting away of the 12-foot corner, which projected into the river at this place.

From 12th Street to Stewart Avenue, the river has been deepened below the hydraulic grade line to a depth of 26 feet. Also a strip from 400 feet above 18th Street to Stewart Avenue was made 200 feet wide.

At Canal Street, the old jack-knife bridge with projecting piers has been removed, and a new bridge of the bascule type—the same as at State, Randolph and Harrison Streets—is in process of erection. The river from Canal Street to 22nd Street has been widened in the east side about 30 feet.

The deepening of the river to 26 feet, from 22nd Street to about 500 feet west of Main Street, is almost completed. Along this stretch the river has been widened for a distance of about 300 feet at Collision Bend.

From 150 feet east of Halsted Street to 150 feet west of Halsted Street, the river was deepened to 28 feet.

From 900 feet east of Main Street to 300 feet west of Main Street, the river has been widened to 200 feet.

The old center pier bridge and pier at Main Street have been removed and a new bridge of the same type as at Taylor Street is being erected.

The old center pier bridge and center pier at Ashland Avenue have been removed, and a new bridge of the Page Bascule Type, with a clear opening of approximately 140 feet, with a 40-foot by-pass on each side of the river, is in process of erection.

The removal of the State Street center pier bridge has been contracted for, and a bridge of bascule type with 140-foot clear opening, and by-passes on each side, is to be erected immediately.

In view of the foregoing improvements that are being carried out now, and many others which will follow as quickly as said work can be performed, we feel justified in asking you to permit the Sanitary District of Chicago to increase the flow as hereinbefore suggested.

The Sanitary District of Chicago has ample funds to pay for all of these improvements as fast as they are carried out and many others that are being matured, as the Legislature during last spring empowered the District to issue $5,000,000 additional bonds, besides, the tax levy will be somewhat larger than in the past.

While we believe that the improvements that have been made on the Chicago River, and the additional improvements that will be completed in the very near future, warrant us fully to ask for your permission for a full flow of 300,000 cubic feet per minute, but inasmuch as we desire to give the greatest consideration to the navigation interests on the Chicago River, we will ask only for 250,000 cubic feet per minute until the close of navigation.

Trusting that you will immediately grant us said permission, we are,

Respectfully,

(Signed) WILLIAM H. BAKER.
JOSEPH C. BRADEN.
ZINA R. CARTER.
FRANK X. CLOIDT.
WILLIAM LEGNER.
THOMAS A. SMYTH.
THOMAS J. WEBB.
FRANK WENTER,
Board of Trustees of the Sanitary District of Chicago.

(Following endorsements on back of said document):
Office of Secretary

Office, Chief of Engineers.

2560 of 1900
———
40 Oct 21 35242 1901.
———
1901 69

War Department.

War Department.

Chicago, Ill.
October 16, 1901.

Board of Trustees of the
Sanitary District of Chicago:

Requests permission, for reason stated within, to increase the flow in the Chicago River from 200,000 cu. ft. per minute to 250,000 c. f. p. m. during that period of the day allowing a flow of 200,000 c. f. p. m.

Incloses letter signed by William H. Baker, Sec'y, to Maj. J. H. Willard, dated October 16, 1901.

1 Inc.

Incls. 74 noted in Map Files, Dec. 24, 1901.
Rec'd Office Chief of Engrs Jan 20 1903,
back with 78.
File 55, 67, 68, 70, 73. Permit & pleadings.
Inc. 70 & 1 Addt. Accompg.
Rec'd Oct 19 1901, Rec. Div. War Dep't
Chief of Engineers.

2 Indorsement.
Office Chief of Engineers
U. S. Army.

Oct. 23, 1901.

Respectfully referred to Lieut. Col. O. H. Ernst, Corps of Engineers for report. To be returned. By command of Brig. Gen. Gillespie.

(Signed) A. McKenzie,
Colonel, Corps of Engineers.

35242
———
69 U. S. Engineer Office
Incls. 70 accomp'g. Northwest Division Chgo 18 Rec'd
Oct. 26, 149
———
1901.

Third Indorsement.
Office of Division Engineer,
Northwest Division

Chicago, Ill. Nov. 5, 1901.

Respectfully returned to the Chief of Engineers with report of this date.

(Signed) O. H. Ernst.
Lt. Col. Corps of Engineers,
35242-69 *Div. Engr. N. W. Div.*

Inclos. 70 accompg.
1 inclo.

Fourth Indorsement.
Office Chief of Engineers
U. S. Army.

November 9, 1901.

Respectfully returned to the Secretary of War.

By direction of the Secretary of War, the Sanitary District of Chicago is required to regulate the discharge of water into the Chicago Drainage Canal so that the maximum flow through the Chicago River shall not exceed 200,000 cubic feet per minute from midnight to 4 P. M. nor 300,000 cubic feet per minute from 4 P. M. to midnight.

Application is now made by the Board of Trustees for permission to increase the flow between midnight and 4 P. M. daily, to 250,000 cubic feet per minute.

In the accompanying report of the 5th instant, the local engineer officer Lieut. Col. O. H. Ernst, Corps of Engineers, recommends that, in lieu of the present authorized rates of flow as stated above, authority be granted the applicant to regulate the discharge so that the maximum flow through the Chicago River shall not exceed 250,000 cubic feet per minute throughout the 24 hours of the day the Board to be responsible for all damages resulting thereby to navigation interests.

I concur in this recommendation; it being understood that this permission will be subject to modification should the change authorized prove dangerous to navigation.

Previous papers herewith.

(Signed) G. L. Gillespie.
35242 *Brig. Gen. Chief of Engineers.*

69

Inclos 55, 67, 68, 70, 73, accomp'g.
Rec'd Nov 11, 1901. Rec. Div. War Dept.
Back Assistant Secretary.
(Asst. Secy's Office War
(Stamp) Dept. Nov. 15, 1901)

(Fifth Indorsement)
War Department.
November 25, 1901.

Approved as recommended by the Chief of Engineers, with the express understanding that this permission will be subject to such modification as the public interest may require, it being further understood that the Board is to be responsible for all damages inflicted upon navigation interests.

Let formal instrument of authority be prepared.

(Signed) WM. .... SINGER,
Assistant Secretary of War.

Rec'd Nov. 26, 1901. Record Div. War Dept.
Back Judge Advocate Gen'l.

(Seventh Indorsement)

6353 B

War Department
Judge-Advocate-General's Office.
Washington, D. C., Nov. 4, 1901.

Respectfully returned to the Secretary of War with instrument prepared in duplicate.

(Signed) GEORGE B. DAVIS,
Judge-Advocate-General.
(Stamped) Chief Clerk Dec 5, 1901,
War Dept.

Rec'd Dec 5, 1901. Record Div. War Dep't.
back. Correspondence.
Rec'd Dec 7, 1901. Record Div. War Dep't.
back Chief of Engineers.

Letterhead of the Sanitary District
of Chicago.
Chicago, October 16, 1901.

Maj. J. H. Willard,
United States Government Engineer,
1637 Indiana Avenue, City.

Dear Sir:

I have been directed by the Board of Trustees of the Sanitary District of Chicago to forward to you the inclosed letter, addressed to the Secretary of War, which is in regard to increasing the flow of water in the Chicago River.

The Trustees would feel very grateful to you for your cooperation and assistance in bringing about the desired permission from the Secretary of War, and they desire that I

suggest that you take such action in the matter as you may deem consistent.

Yours very respectfully,
(Signed) WM. H. BAKER,
Vice-President.

Indorsed on the back as follows:

Office of the Secretary. Office Chief of Engineers.
Oct 19 2560/41 1901 Oct 21 35242/70 1901.
War Department War Department

U. S. Engineer Office
Chgo Northwest Division 149
18/1 Rec'd Oct. 26. 1901.

Chicago, Ill.,
Oct. 16, 1901.

Board of Trustees,
Sanitary Dist. of Chicago,
Wm. H. Baker, Sec'y.
to
Major J. H. Willard.
Rec'd. Office Chief of Engineers
Back Dec 7, 1901.
with inc. 69
Rec'd Office Chief of Engineers
Back Nov 7, 1901.
With inc. 69.

Letterhead of the Sanitary District
of Chicago.

Chicago, Oct. 24, 1901.

Hon. Elihu Root,
Secretary of War of the United States,
Washington, D. C.

Dear Sir:

The undersigned respectfully petition you as Secretary of War to give us permission for an increased flow in the Chicago River, over the 200,000 cubic feet a minute now in force by your order of July 23, 1901. We, the petitioners, inasmuch as a number of very material improvements have been made in the Chicago River, such as removing center pier bridges, widening the river at many points, and also deepening the same, thereby allowing a much greater flow without any perceptible increase in velocity of the current, believe that we are fully justified in petitioning you to grant

to the Board of Trustees of the Sanitary District of Chicago permission to increase the flow from 200,000 to 250,000 cubic feet per minute, during that period of the day allowing a flow of 200,000 cubic feet per minute.

Below we enumerate the following improvements.

The old Randolph street center pier bridge is now removed, and all obstructions which hindered navigation will be out of the way in but a few weeks, and a bascule type with 140 foot opening, will be erected, similar to that on Taylor street.

The old Harrison street center pier bridge is removed, and a new bascule type bridge, with 140 foot opening, with by-passes on each side, is being erected instead.

At Taylor street the new bascule bridge is in operation, which has a clear opening of 120 feet.

The new bascule bridge of the Chicago Terminal Transfer Railway Company is about ready to be operated, and the old center pier bridge will immediately be removed. (Tested October 25. Opened in 1m 55s.)

Just north of 12th street the river has been widened by the cutting away of the 12 foot corner, which projected into the river at this place.

From 12th street to Stewart avenue, the river has been deepened below the hydraulic grade line to a depth of 26 feet. Also a strip from 400 feet above 18th street to Stewart avenue was made 200 feet wide.

At Canal street the old jack-knife bridge with projecting piers has been removed, and a new bridge of the bascule type—the same as at State, Randolph and Harrison streets—is in process of erection.

The river from Canal street to 22nd street has been widened in the east side about 30 feet.

The deepening of the river to 26 feet, from 22nd street to about 500 feet west of Main street, is almost completed. Along this stretch the river has been widened for a distance of about 300 feet at Collision Bend.

From 150 feet east of Halsted street to 150 feet west of Halsted street, the river was deepened to 28 feet.

From 900 feet east of Main street to 300 feet west of Main street, the river has been widened to 200 feet.

The old center pier bridge and pier at Main street have been removed, and a new bridge of the same type as at Taylor street is being erected.

The old center pier bridge and center pier at Ashland ave-

nue have been removed, and a new bridge of the Page bascule type, with a clear opening of approximately 140 feet, with a 40 foot by-pass on each side of the river, is in process of erection.

The removal of the State street center pier bridge has been contracted for, and a bridge of bascule type with 140 foot clear opening, and by-passes on each side, is to be erected immediately.

In view of the foregoing improvements that are being carried out now, and many others, which will follow as quickly as said work can be performed, we feel justified in asking you to permit the Sanitary District of Chicago to increase the flow as hereinbefore suggested.

The Sanitary District of Chicago has ample funds to pay for all of these improvements as fast as they are carried out, and many others that are being matured, as the legislature during last spring empowered the District to issue $5,000,000 additional bonds, besides, the tax levy will be somewhat larger than in the past.

While we believe that the improvements that have been made on the Chicago River, and the additional improvements that will be completed in the very near future, warrant us fully to ask for your permission for a full flow of 300,000 cubic feet per minute, but inasmuch as we desire to give the greatest consideration to the navigation interests on the Chicago River, we will ask only for 250,000 cubic feet per minute until the close of navigation.

Trusting that you will immediately grant us said permission, we are,

Respectfully,
(Signed) Wm. H. Baker,
Jos. C. Braden,
Zina R. Carter,
Frank X. Cloidt,
Wm. Legner,
Thomas A. Smyth,

Frank Wenter,
Board of Trustees of the Sanitary District of Chicago.

Indorsed on the back of said document is the following:

U. S. Engineer Office
Chicago, Ill.
Received.

Oct 25 1901

Office Chief of Engineers
35242

72
Oct 28 1901
War Department.

Chicago, Ill., Oct. 24, 1901.

Board of Trustees of the
Sanitary District of Chicago.

They petition for permission to increase the flow in Chicago River from 200,000 to 250,000 cu. ft. per minute, inasmuch as a number of material improvements have been made in the river such as the moving center pier bridges, widening the river and deepening it. They enumerate the improvements made in the river and those now in progress.

They believe these improvements warrant them in asking for permission for 300,000 ft. per min. but they ask for only 250,000 until the close of navigation."

Letterhead of
The Sanitary District of Chicago.

To the Honorable Elihu B. Root,
Secretary of War,
Washington, D. C.

Dear Sir:

This being the closed season of navigation and no vessel interest being jeopardized by an increased current in the Chicago River, we feel it to be in line with the duty we owe to the citizens of Chicago and the obligation which rests upon us to use every endeavor to comply with the State law which brought the Sanitary District into existence, to request you to grant us permission to increase the flow through the Chicago River from 250,000 cubic feet per minute to 350,000 cubic feet per minute. We ask this in the interest of the health of the people of Chicago. The work of this District for construction, right of way, administration and interest has already cost our citizens $41,000,000.00; and other millions are being expended in the work of deepening and widening the Chicago River and substituting bascule bridges for the obstructive center pier structures which are so harmful to navigation. Our wish is, by introducing the largest possible volume of water from the lake during the closed season of navigation, to draw into the channel the

largest amount of contamination that can be reached by the current thus introduced. As you know, for long years the discharge of our sewers has been into the lake and the resulting foul sediment defiles the shore line for miles of frontage. When storms, such as we have recently been subjected to, churn up this slimy deposit it often drifts out to our water intakes making our water supply unpalatable and unhealthful. The more of this turbid water that we can draw into our channel, the better for the health of our people and the sooner shall we be able to carry off the accumulations of sewage deposit which line our shores. We are working with a steadfast purpose of making the Chicago River what it ought to be as a navigable stream and we feel a justifiable pride in what we have already accomplished in that direction.

We are now in the courts condemning lands for widening and deepening the river which will cost this District enormous sums of money, which we will gladly pay to hasten the results we have set out to attain.

We recognize your responsibility as the guardian of the interest of navigation but we believe that you will readily admit that even such vast interest ought and must make concessions to conserve the health of 2,000,000 of people and we shall hope for your favorable action upon our petition.

Very respectfully,
(Signed) THOMAS A. SMYTH,
JOS. C. BRADEN,
ZINA R. CARTER,
THOMAS J. WEBB,
FRANK X. CLOIDT,
FRANK WENTER,
WM. H. BAKER,
WM. LEGNER,
ALEXANDER J. JONES."

The above document has the following indorsements:

Office Chief of Engineers
Jan 2 35242 1903 35242

78
War Department
Office of the Secretary
Jan 5 3188 1903
War Department.
United States Engineer Office
Chi R Chicago, Ill. 26 3/2
Dec 30 1902 889
Rec'd ——————

Chicago, Ill.,
Dec. 29, 1902.

Sanitary District of Chicago:

Requests permission of Secretary of War to increase the flow through the Chicago River from 250,000 to 350,000 cubic feet per minute.

Incls. 80 noted in Map Files, Jan. 27, 1903.
35242

69474 herewith

Jan 21, 1903 copy of inclo 80 to Lieut. Col. Ernst, by indorsement.

Rec'd back Office Chief of Engrs Jan 20 1903
Inclo 69, 74 & 2 additional Incls.

(First Indorsement.)
U. S. Engineer Office,
Chicago, Ill., Dec. 30, 1902.

Respectfully forwarded to the Chief of Engineers, with the recommendation that the petition be granted for the season closed to navigation; that is, that the flow of 350,000 cubic feet per minute be authorized until March 31st next, after which it shall be reduced to 250,000 cubic feet per minute, as now authorized.

(Signed) O. H. Ernst,
Lieut. Col., Corps of Engineers, Division Engineer, N. W. Div.

2nd Indorsement
Office Chief of Engineers,
U. S. Army.
January 5, 1903.

Respectfully forwarded to the Secretary of War concur-

ring in the recommendation of Lieutenant Colonel Ernst in 1st indorsement hereon.

By instrument dated December 5, 1901, the Secretary of War granted the Sanitary District of Chicago permission to regulate the discharge of water into the drainage canal so that the maximum flow through the Chicago River should not exceed 250,000 cubic feet per minute throughout the 24 hours of the day.

(Signed) G. L. GILLESPIE,
Brig. Gen. Chief of Engineers, U. S. Army.
(Stamp of Chief Clerk)
Rec'd Back Jan 5 1903. Record Div.
War Dept.
Judge Advocate General.

35242

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78 Inclos. 69 and 74, accomp'g.
Rec'd Jan. 6, 1903—J. A. G. O.

6353 4th Indorsement C. B.
War Department.
Judge Advocate General's Office.
Washington, D. C., Jan. 16, 1903.

Respectfully returned to the Secretary of War with instrument prepared in duplicate.

(Signed) GEORGE B. DAVIS,
Judge-Advocate General.

Stamp as follows: Chief Clerk, Jan. 16, 1903, War Dept.
Rec'd Jan 16, 1903. Record Div.
Back War Dept.
Rec'd Jan 16, 1903. Record Div.
Back War Dept.
Rec'd Office Chief of Engineers Jan. 20, 1903.

Letter Head of The Sanitary District of Chicago.
Chicago, Dec. 3, 1906.

W. H. Bixby,
Col. Corps of Engineers, U. S. A.,
Federal Building, City.

Sir:

Although I personally delivered the maps and plans hereinafter enumerated, to you this afternoon, yet as a matter of record I think best to put it in the form of a letter:

A form of permit prepared by the attorney of the Sanitary

District of Chicago and submitted for the signature of the Secretary of War.

A description of the project of the Sanitary District for a channel to be known as the Calumet-Sag Channel designed to reverse the flow of the Calumet River.

A brief argument setting forth the causes which make this work necessary.

A map showing the water shed of the Calumet region in Indiana and Illinois.

A map showing the location of the proposed Calumet-Sag Channel.

A map showing the proposed guard lock and controlling works at entrance to the artificial channel of the Calumet-Sag Channel.

A profile on the center line of the proposed Calumet-Sag Channel.

Thanking you for your kindness in undertaking to forward this matter to the Secretary of War, I am,

Yours very truly,

(Signed) ISHAM RANDOLPH,

Chief Engineer.

The above document is indorsed as follows:

Office of Chief of Engineers.

Dec. 6 28918 1906

67

War Department.

United States Engineer Office.

Cal. R. Chicago, Ill. 295.

Rec'd Dec. 3, 1906. H. 5353

Chicago, Ill.,

December 3, 1906.

Sanitary District of Chicago.

Isham Randolph, C. E.

Submits form of permit desired from the War Department to authorize the construction of proposed Calumet-Sag Channel as described in project, argument and maps submitted herewith.

7 inclosures in triplicate.

Letter Head of Sanitary District of Chicago.
Chicago, Nov. 28, 1906.

Col. W. H. Bixby,
Corps of Engineers, U. S. A.
Federal Building, City.

Dear Sir:

By order of the Board of Trustees of the Sanitary District of Chicago, I have the honor to transmit herewith copy of the permit desired from the Secretary of War.

Yours very truly,
(Signed) ROBERT R. MCCORMICK,
President.

Indorsed on back as follows:

Office of Chief of Engineers.
Dec. 6. 28918 1906.

57

Office of the Secretary.
War Department. 12721/36
Nov. 20.
War Department 1907.
Cal. R. 5353. United States Engineer Office.
Chicago, Ill. 295/0/0.
Rec'd Dec. 3, 1906.

Chicago, Ill.,
Nov. 28, 1906.

Sanitary District of Chicago,
Robert R. McCormick, Pres.

Forwards form of permit desired from War Dept. for proposed Calumet "Sag Channel."

Note: See letter of Dec. 3 from Isham Randolph C. E. in lieu of the above.

"Whereas, Heretofore, to wit, on the 8th day of May, A. D. 1899, the Secretary of War issued to the Sanitary District of Chicago a permit in words and figures as follows, to wit:

' "Whereas, by Section 10 of An Act of Congress, approved March 3, 1899, entitled "An Act Making Appropriations for the Construction, Repair and Preservation of Certain Public Works on Rivers and Harbors, and for other purposes," it is provided that it shall not be lawful to alter or modify the course, location, condition or capacity of the channel of any navigable water of the United States unless the work has been

recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same; and

" 'Whereas, The Sanitary District of Chicago, a municipal corporation organized under the laws of the State of Illinois, has constructed an artificial channel from Robey Street, Chicago, to Lockport, and has been heretofore granted permission by the Secretary of War to make certain improvements in the Chicago River for the purpose of correcting and regulating the cross section of the river so as to secure a flowage capacity of 300,000 cubic feet per minute with a velocity of 1 1/4 miles an hour, it being intended to connect the said artificial channel with the West Fork of the South Branch of the Chicago River at Robey Street, in the said City of Chicago; and

" 'Whereas, the said Sanitary District of Chicago has now applied to the Secretary of War for permission to divert the waters of the said Chicago River and cause them to flow into the said artificial channel at Robey Street as aforesaid; and

" 'Whereas, the said Sanitary District of Chicago represents that such movable dams and sluice gates as are necessary to, at all times, secure absolute and complete control of the volume and velocity of flow through the Chicago River have been constructed:

" 'Now, Therefore, The Chief of Engineers having consented thereto, this is to certify that the Secretary of War hereby gives permission to the said Sanitary District of Chicago to open the channel constructed and cause the waters of Chicago River to flow into the same subject to the following conditions:

" '1. That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the Sanitary District of Chicago to Congress for consideration and final action, and that this permit shall be subject to such action as may be taken by Congress.

" '2. That if, at any time, it become apparent that the current created by such drainage works in the South and Main Branches of Chicago River, be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such an extent as may be demanded by navigation and property interests along said Chicago River and its South Branch.

" '3. That the Sanitary District of Chicago must assume

all responsibility for damages to property and navigation interests by reason of the introduction of a current in Chicago River.

"'Witness my hand this 8th day of May, 1899.

"'R. A. ALGER,
"'*Secretary of War.*

"'JOHN M. NELSON,
"'*Brig. Gen'l, Chf. of Engrs.*
"'*U. S. A.*'"

And Whereas, The said Sanitary District of Chicago, in accordance with said permit, issued as aforesaid, did open its said channel in the said permit mentioned and caused the waters of the Chicago River to flow therein and therethrough to and into the Des Plaines River and has ever since maintained said flow of water from the said Chicago River and through its said Main Channel as aforesaid for the purposes of sanitation and commerce; and

Whereas, in furtherance of the objects and purposes of said Sanitary District of Chicago, said District now proposes to construct a channel, collateral to its Main Channel in said permit aforesaid mentioned, in order to provide a proper outlet for the drainage and sewage of that portion of said District adjacent to the Calumet River, which said proposed channel is to connect with the Little Calumet River at a point near the City of Blue Island and extend thence southwesterly along the depression generally known as "The Sag" for a distance of about sixteen miles, connecting with the Main Channel of the said Sanitary District at a point on said channel known as "Sag Bridge," or more particularly, with original Section 5, of the Main Drainage Channel. The route of said proposed channel, and its connection with said Main Channel of said Sanitary District and said Little Calumet River, being more fully and completely shown by the maps and plats hereto attached and marked Exhibits "A," "B," and "C," respectively; and

Whereas, The said Sanitary District of Chicago, pursuant to the authority vested in it by the State of Illinois, has duly ordained that said proposed collateral channel be constructed of the following dimensions, to wit: Of a width of ninety feet through the rock portions of said channel, with vertical sides, and of a width of seventy feet through the earth channel, with side slopes of five on three. The minimum depth of

said artificial channel, below flow line, to be twenty-two feet; and that, upon its completion, it be a navigable channel or canal subject to the uses of navigation to the same extent as the Illinois and Michigan Canal; and that it be so connected with the Little Calumet River as to cause the waters of said Little Calumet River to flow therein, thus reversing the said flow, at ordinary stages, from Lake Michigan, and from thence into the Main Channel of the said Sanitary District, and through said Main Channel in the same manner as the waters of the Chicago River now flow there through; and

Whereas, It further appears by the plans submitted by said Sanitary District of Chicago, and accompanying this permit, that the proper provision has been made for controlling the waters flowing from the said Little Calumet River into said collateral channel of said Sanitary District, and for the protection of the people living in the valleys of the Des Plaines and Illinois Rivers from danger to their lives or property by reason of flood waters in said Little Calumet River; and

Whereas, It further appears that the said Sanitary District of Chicago has laid out its right of way for the construction of said collateral channel and is ready to procure the same by condemnation or purchase; and

Whereas, It further appears that said right of way will cost several hundred thousands of dollars, and that the proposed channel will cost, approximately, twelve millions of dollars; and

Whereas, It further appears that the said Sanitary District of Chicago desires, before incurring the expense of procuring said right of way and the construction of said collateral channel, to have the consent and permission of the Federal Government to the diversion of the waters of the Little Calumet River into its said collateral channel as aforesaid that it may be assured that its construction of said collateral channel will not have been in vain; and

Whereas, It further appears that the construction and maintenance of said channel, as contemplated, will be for the benefit of the health of the people of said District and in the interest of commerce and navigation of both the Little Calumet and Illinois Rivers;

Now, Therefore, The Chief of Engineers consenting thereto, this is to certify that the Secretary of War hereby gives permission to said Sanitary District of Chicago to construct

its said collateral channel, as herein proposed, and as shown by the plans transmitted herewith; and to connect the same with said Little Calumet River and to cause the waters of said Little Calumet River to flow therein and from thence into the Main Channel of said Sanitary District of Chicago and from thence into the Des Plaines and Illinois Rivers.

Witness My hand this ________ day of December, A. D. 1906.

____
Secretary of War.

The above document has the following indorsement:

Office of Chief of Engineers.
Dec. 6. 28918 1906.

65
War Department.
United States Engineer Office.
Cal. R. Chicago, Ill. 295/0/1.
Rec'd Dec. 3, 1906. (G) 5353.

Form of War Department permit desired by Sanitary District of Chicago for proposed construction of Calumet-Sag Channel as described in Maps "A," "B," and "C," accompanying.

"The Calumet-Sag Channel.
The Project.

It is purposed to excavate a channel southwestward from the confluence of 'Stoney Creek' with the 'Little Calumet.' The point of beginning is in the S. W. ¼ of Sec. 32-37-14.

The line of the channel to be excavated passes through the Town of Blue Island crossing Western avenue between Canal street and Devonshire street. It passes the uplift known as 'Lane's Island,' on the south side, and enters the Sag Valley proper on Sec. 22-37-12. Thereafter following the general location of the abandoned channel formerly used as a feeder to the Illinois and Michigan Canal and commonly known as the 'Sag Feeder.' It crosses the channel of the Illinois and Michigan Canal in Section 14-37-11, near the station on the Chicago & Alton R. R. now called 'Lambert' but formerly known as 'Sag Bridge.' It enters the main channel of the

Sanitary and Ship Canal at or about Station 975 in Contract Section 5, Civil Section 14-37-11. The dimensions of this channel will be, in the rock sections and in the sections underlaid with rock, which must be walled, ninety (90) feet wide with vertical sides, with such additional width as may be necessary to admit of cutting the sides with channeling machines. The channel in earth will have a bottom width of seventy (70) feet and side slopes of five (5) feet horizontal to three (3) feet vertical. The minimum depth of water below the hydraulic grade line is to twenty-two (22) feet. The flow of water through the channel must be under absolute control and the volume of water passing through it must not exceed four thousand (4,000) cubic feet per second. In normal seasons with mean lake stages the cross section and slope of the channel will—within a moderate variation—control the volume of flow, but to meet flood conditions absolute mechanical means must be provided to control the flow volume. The means of control which form integral parts of the project are: A guard lock at the Little Calumet end of the artificial channel which can be closed upon the manifestation of flood probabilities and then operated for navigation purposes only: A movable dam which may be of the Bear Trap type or of the Stoney Gate type, whichever a fuller study of the conditions to be met shall point to as the most desirable form of construction. Under normal conditions this movable dam will be closed barring out all flow from the Calumet River. When so closed the normal flow into the artificial waterway will be through the guard lock. When it becomes necessary to close the guard lock then water will be admitted by way of the movable dam in such volume—up to the prescribed flow of 4,000 cubic feet per second—as the conditions to be met seem to warrant. There will be a moderate deepening of the Calumet River from the Guard Lock eastward as far Riverdale where the Illinois Central R. R. crosses the said river. The channel hereinbefore described is to be spanned by movable bridges. The railroads to be crossed are the Chicago, Rock Island & Pacific R. R. main line and one transfer line; the Chicago Junction R. R., the Chicago & Grand Trunk Ry., the Wabash R. R., the Chicago & Joliet Electric R. R. and the Chicago & Alton Railway.

(Signed) Isham Randolph,
Chief Engineer Sanitary District of Chicago."

The above document has the following indorsement:

"Office of Chief of Engineer.
Dec. 6. 28918 1906.

60
War Department.
United States Engineer Office.
Cal. R. 295/0/2.
Rec'd Dec. 3, 1906. 5353.
E.

Sanitary District of Chicago,
Isham Randolph, Chf. Engr.

Project for excavating a channel, together with necessary controlling works, from confluence of Stoney Creek and Little Calumet River to Sanitary District Drainage Canal at "Sag Bridge."

Dimensions of channel, 90′ wide, 22′ deep requiring flow of about 4,000 cu. ft. per second, and to be spanned by movable bridges."

Argument for Reversing the Flow of the Calumet River.

The map which accompanies this report gives the outlines or boundaries of the Calumet watershed. This watershed has a total area of 825 square miles; of this area 485 square miles belong to the State of Indiana and the remaining 340 square miles belong to the State of Illinois. The occupation of this territory for urban and industrial uses began first in Illinois but Indiana is forging to the front also. The advantages of level plains easily accessible to the cheapest of all forms of transportation, water borne carriers, and offering facilities for easy and cheap railroad construction has tempted capitalists to create great manufacturing plants, such as steel mills, car building shops, ship yards and their allied enterprises, and these have found a quick response to their invitation to the railroads centering in Chicago to come in and possess so much of the land as was needed for great freight yards where the raw materials needed by the manufacturers could be assembled for convenient delivery to the furnace, the forge and the workshop; from whence the finished product would be sent forth by these same railroads to purchasers in all parts of the land. In addition to manufacturing interests are the great grain handling conveniences which have found relief from the congested and contracted conditions along the Chicago River and have been planted along the Calumet River. All of these manifold industries give employment to multi-

tudes of men, and men must live within reasonable distances of their work and the normal man must have his mate, and thus mated they must "increase and multiply and replenish the earth," and they are doing it, and the Calumet region is growing populous. Marshes once the exclusive home of wild forms of life are now being reclaimed and streets are being raised above the flow line and houses front upon them, and the debris of manufactories and the ashes from the hearths of homes are serving to lift the general plane of the inhabited places above the level of the swamp. But people make sewage and this sewage must find a vent. That vent is now into the Calumet River and the Calumet River empties into Lake Michigan and Lake Michigan furnishes the drinking water for Chicago. The wealthy may drink "hydrox," "Waukesha" and mineral waters, but the poor, who are the overwhelming majority of the population, must drink the waters of Lake Michigan and humanity, duty, interest, every known argument demands that this water supply be purified. Investigation has shown that for Chicago the solution is to be found and found only in turning away the streams which flow into the lake and giving them a westward flow into which all the city's sewers must be turned.

It is argued that this sewage can be disposed of upon sewage farms. A sewage farm to be successful must be underlaid by a porous soil. Chicago is environed by a clay subsoil overlaid in almost all cases by a black loam of uncertain depth, hence the land disposal of sewage is not a solution of its problem available to Chicago. The verdict went forth 20 years ago condemning land disposal and a re-opening of the case can only result in an affirmation of the old verdict. The Chicago River has been reversed and is doing for the territory which it serves all that its projectors designed it to do. The necessity of caring for the sewage of the entire city brought about the annexation to the Sanitary District of nearly all of the low ground of the Calumet watershed within the State of Illinois; an area of 94.48 square miles and it matters not what the population of that territory may be today, when we know that only by vigorous prosecution of the projected reversal of the Calumet River can the work be carried to completion in time to meet the necessities of the population which—if there be no arrested development—will throng this region before the waters can be made to flow westward.

The above document has the following indorsement:

Office of Chief of Engineers.
Dec. 6. 28918. 1906.

63
War Department.
United States Engineer Office.
Cal. R. Chicago, Ill. 295/0/3.
Rec'd Dec. 3, 1906. 5353.
F.
Sanitary District of Chicago.

Argument for reversing the flow of Calumet River with map "D" accompanying.

Letterhead of the Sanitary District of Chicago.

September 2nd, 1907.

To the Honorable, the Secretary of War,
Washington, D. C.

Sir:

The Board of Trustees of the Sanitary District of Chicago has laid out and established a proposed right of way, which it expects to acquire, extending from the North Branch of the Chicago River, at Lawrence avenue, Chicago, to the western boundary of Lake Michigan, in the Village of Wilmette, Illinois, through which right of way it intends to construct and maintain a channel, as an adjunct to its Main Channel (including the Chicago River), extending from Lake Michigan to Lockport, Illinois.

The entrance of the proposed channel into Lake Michigan is shown upon the accompanying plat. In order to protect the mouth of the proposed channel against filling in with sand by the storms of Lake Michigan, it is proposed to construct a pile crib, filled with rock, extending out into Lake Michigan from the shore line a distance of, approximately, one thousand feet; and thence in a northwesterly direction a distance of, approximately, eleven hundred feet. It is further proposed to deposit within the limits of said proposed crib the spoil arising in the construction of the channel from the shore of Lake Michigan to the Chicago & Northwestern Railroad Company's tracks, in the City of Evanston, a distance of some two miles.

The accompanying plat of the plan outlined above is herewith submitted and the Board of Trustees will be grateful to

you if you will examine the same and approve, in order that work may be begun at as early a date as possible.

Yours very truly,

(Signed) G. M. WISNER,
Chief Engineer.

The above document is indorsed as follows:

Office of the Secretary.
Sep. 11. 14130. 1907.
War Department.
U. S. Engr. Office, Chicago Rivers and Harbors.
Rec'd Chicago, Ill., Sep. 4, 1907.
Office No. Chi. H N 1400.

Chicago, Ill.,
September 2, 1907.

Sanitary District of Chicago,
By G. M. Wisner, Chief Engineer.

Requests approval of proposed drainage channel to connect Lake Michigan at Wilmette, Ill., with North Branch of Chicago River; and permission to construct pile cribs in Lake Michigan at mouth of same and to deposit filling within the limits of such cribs.

Three inclosures—blueprints.

Inclo. 1 in Map Files. 8961 Flat.

Ford by Col. Bixby.

September 14, 1907, Indst. to Col. Bixby with inclos. 2 & 3, and copy of inclo. 5 accomp'g.

9:30 rec'd back Office Chief of Engineers August 16, 1901.

Inco. 5, 7, 9 and one addl.

Incls. 1, 2, 4 & W. D. P. C.

1st Indorsement.
Office District Engineer.
Chicago Rivers & Harbors.
Chicago, Ill., September 4, 1907.

1. Respectfully forwarded to the Chief of Engineers, U. S. Army, with recommendations that the applicant be notified that no objection will be made by the War Department to the constructions described in this request and its enclosed blueprint, provided that:

(a) The pier constructions, the filling behind the same, and the excavation of the proposed channel, to be under the supervision of the Chicago U. S. Engineer Office, so far as to see that the terms of the permit are not exceeded.

(b) The total diversion of water from Lake Michigan through Chicago River in the Illinois River to be no greater than already authorized by past War Department permits.

(c) The work to be commenced before December 31, 1908, and completed within five years thereafter.

2. Reasons for these recommendations are given in the report of this same date, herewith enclosed.

(Signed) W. H. Bixby,
Lieut. Col. Corps of Engineers.

2 inclosures, 1 (b. p.) in triplicate.

2nd Indorsement.
War Department.
Office of the Chief of Engineers.
Washington,
September 10, 1907.

1. Respectfully forwarded to the Secretary of War.

2. The Sanitary District of Chicago proposes to connect Lake Michigan with the upper end of the North Branch of the Chicago River, for the purpose of diverting a limited quantity of water from the lake into the upper river so as to flush the sewage of the northern part of Chicago; and to construct a pile crib filled with rock, and other material, along the shore of Lake Michigan, about 15 miles north of the mouth of the Chicago River, for a length of about 1100 feet, and for a distance outward into the lake about 1,000 feet, reaching to about 10 feet depth of water.

3. This project has been under consideration by Lieut. Col. Bixby, to whose statement, in first indorsement hereon and in letter of the 4th instant herewith, attention is respectfully invited. Colonel Bixby recommends that the Sanitary District be advised that the War Department will make no objection to the project, as set forth in the applicant's letter, and indicated on the accompanying drawing, provided the following conditions are complied with:

(a) That the pier constructions, the filling behind the same, and the excavation of the proposed channel, shall be done under the supervision of the district engineer officer at Chicago, so far as to see that the work authorized is not exceeded;

(b) That the total diversion of water from Lake Michigan through the Chicago River into the Illinois River shall be no greater than already authorized by past War Department permits.

(c) That the work shall be commenced before December 31, 1908, and be completed within five years thereafter.

4. In this recommendation I concur.

(Signed) A. MACKENZIE,
Brig. Gen. Chief of Engineers, U. S. Army.

64900

Inclos. 1, 2 & 4 accomp'g.
Stamp: Chief Clerk War Department, Sept. 11, 1907.
Cor. 2:20, Sept. 11.
Received Sept. 11, 1907. M. & R. Div. War Dept.
Rec'd Office Chief of Engrs. Sept. 13, 1907.

4th Indorsement. WHB-WJ.
War Department.
Office of the Chief of Engineers.
Washington.
August 11, 1911.

1. Respectfully returned to the Secretary of War.

2. Previous action is shown by 2d indorsement hereon and Department letter dated September 11, 1907, copy herewith, to Mr. Wisner.

3. Attention is invited to the accompanying letter dated July 21, 1911, from Mr. Wisner, in which he described certain deviations in the structures, as built, from the plans on which the prior action of the department was based and requests that permit be granted for the construction as built.

4. Inviting attention to 1st indorsement on said letter by the district officer, Lieut. Col. Geo. A. Zinn, Corps of Engineers, I recommend that Mr. Wisner be informed, with return of one of the maps, that the department will interpose no objection to the maintenance of the structures as built and shown on map now presented provided they do not prove obstructive to navigation or otherwise detrimental to the public interests.

(Signed) W. H. BIXBY,
Chief of Engineers, U. S. Army.

Stamp: Assistant Acting Clerk, Aug. 12, 1911, War Department.

64900

Inclos. 5, 7-9 accompanying.
Aug. 12, 1911, correspondence Division. 11:45.
Rec'd Office Chief of Engrs., Aug. 16, 1911.

Here follows plan of location of proposed North Shore Channel with the following indorsement:

Office Chief of Engineers.
Sept. 6, 1907. 64900.
8961 flat. War Department.
Office of the Secretary.
Sept. 11. 14130. 1907.
War Department.
U. S. Engr. Office, Chicago Rivers & Harbors.
Rec'd Chicago, Ill., Sept. 4, 1907.
Office No. Chi. H N 1400/1.

September, 1907.

Sanitary District of Chicago.

Plan of location of proposed north shore drainage channel between Lake Michigan and North Branch of Chicago River, and crib work in connection therewith.

"War Department. WHB/FJL.
Office of the Chief of Engineers,
Washington.

December 18, 1911.

Memorandum for the Secretary of War:

In 1908, the United States, entered a friendly suit against the Sanitary District of Chicago, the primary object of which was to determine the rights of the district to divert from Lake Michigan by opening a new route from the lake via the Sag crossing from Calumet Lake to the Sanitary District Canal, an amount of water in excess of what was then b[illegible] diverted (so as to secure a total of 14,000 cu. ft. per second), without first obtaining a permit from the Secretary of War in pursuance of Section 10 of the river and harbor act of March 3, 1899. At the time the action was brought the district was diverting, under permission from the War Department, 250,000 cu. ft. per minute (4,166 cu. ft. per second), all of which was diverted through the Chicago River into the drainage canal, the connection with the canal being made at Robey street in the City of Chicago. No increase in this amount has since been authorized by the Department; but by letter of June 30, 1910, the Secretary of War granted the district permission to divide the amount of water already authorized to be diverted (4,166 cu. ft. per second), in such manner as to reach the drainage canal by way of the Calumet River and a connecting channel, as well as by way of the Chicago River.

The bill of complaint in the aforesaid suit was filed in the Circuit Court of the United States for the Northern District of Illinois in March, 1908, and the answer of the defendant

was filed in June of that year. Engineer Department records show nothing further in regard to the progress of the action. It is, however, understood by informal verbal statements of various parties, that the taking of evidence on the part of the Government has been completed, and that the case is now pending. It is, therefore, assumed that the case is ready for a hearing; but so far as the record shows, no hearing has so far been had, nor has a date been set therefor. It is also informally understood that the Sanitary District of Chicago contemplates securing direct Congressional authorization for the project of reversing the flow of the Calumet River and of using the waters of Lake Michigan to the extent of probably 10,000 cu. ft. per second, and that a bill to accomplish this purpose, prepared by the Sanitary District, has been submitted by it informally to the President and been under consideration by the Attorney General.

There always has been and are now many serious objections to the diversion, from not only the point of view of navigation but also of conservation of resources and of sanitation.

The annual levels of the water surface of all the Great Lakes are at present considerably below their average of the past 51 years, and are still dropping rapidly. The present Sanitary District diversion is aiding the rapidity and extent of this undesirable drop of levels, every foot of which will add greatly to the cost of water transportation on the Great Lakes and also lessen the total quantity of freight possible through the Sault, and the St. Mary's, St. Clair, and Detroit Rivers and into lake harbors.

Owing to the few and low water falls and rapids of the Illinois River route and the many and high falls of the St. Lawrence River route, the water diverted from the lakes via Chicago and the Illinois River can be utilized for power only to 1/4 to 1/3 the extent possible by its original route via the Detroit and St. Lawrence Rivers, and will cause a potential loss of power (and corresponding loss of utility or profits) to Canada and New York State, equal to three to four times what Illinois can get from the diversion by its own route. This may mean several million dollars annual loss to Canada as well as to the United States, and is consequently a great waste of natural resources.

The question of injury to public health due to dumpage of filth into rivers is now attracting marked attention throughout the United States, and many states have passed stringent

laws on this subject, sometimes of total prohibition, and Massachusetts at least has found it practicable to stop such dumpages. A national association for prevention of pollution of streams has been incorporated and more active protests and more stringent laws may be expected in future in all states affected by such dumpages. Properly handled, the present authorized diversions at Chicago are sufficient to cover all actual sanitary necessity.

Under all the above circumstances, it seems extremely desirable that, if this injunction can be made permanent, the United States should push the case to final settlement.

(Signed) W. H. BIXBY,
Chief of Engineers, U. S. Army.

28918
1 inclosure (blueprint pamphlet of lake levels).
Inclo. 320 accomp'g."

The above document is indorsed as follows:

December 18, 1911.

Chief of Engineers:

Memorandum for Secretary of War in regard to injunction suit pending before Federal Court in Chicago to determine extent of diversion of water from Lake Michigan for sewerage of Chicago; temporary injunction should be made perpetual and action pushed to that end."

"War Department.
United States Engineer Office,
508 Federal Building.
Misc. 495/33. HBF-r.

Chicago, Ill., Nov. 24, 1913.

From: The District Engineer Officer.

To: The Chief of Engineers, U. S. Army, Washington, D. C.

Subject: Report on Illinois and Michigan Canal.

1. Pursuant to 2nd indorsement dated Sept. 5, 1913, on E. D. 47860/24, the following report and recommendation is submitted. The report required is chiefly as 'to whether the matter is of sufficient importance to justify the U. S. in endeavoring to compel Illinois to spend moneys for maintenance of this canal.'

2. The Illinois and Michigan Canal is a link of the waterway from Lake Michigan to the Mississippi River and extends from the Chicago River to the Illinois River at La Salle, 95.82 miles. It is available for boats of about four feet draft. It is crossed by 75 bridges, 6 of which are swing bridges, the

remainder being fixed spans of heights of from 12 to 25 feet. The present condition of the canal is described in Colonel Zinn's report of March 16, 1912.

3. The importance of this route from the U. S. point of view will be considered by referring briefly to (1) U. S. grants for canal; (2) U. S. appropriations for connecting channels, and (3) surveys, all of which depend on (4) U. S. estimate of commercial importance of the route.

4. Under its authority and responsibility to promote interstate commerce the U. S. Congress in 1822, granted under certain conditions 'the route of the canal and 90-foot strips on either side thereof.' This grant has been held by U. S. Supreme Court (Werling vs. Ingersoll, 1901, U. S. Reports, Vol. 181) to have been mutually abandoned, so far as land section in question was concerned, by the United States and State of Illinois. It has since been contended that this ruling was founded on an error as to fact, it having been discovered that the map had been filed as required by the law of 1822. Further land grants were made in 1827, 1842 and 1854. Canal was completed in 1848. History of the canal up to 1885 is found in Report of Chief of Engineers for 1887, page 2128 et seq. The total receipts by Illinois for canal lands is stated as $5,886,039.88. This amount, added to the tolls, rents, etc., collected by Illinois, as authorized by the United States, is the expenditure by the United States for this canal.

5. The United States' expenditures for connecting channels should also be considered, especially those for Illinois River amounting to about $2,000,000, and those for the Illinois and Mississippi Canal amounting to about $7,000,000. The canal was completed in 1907. It is plainly seen in the reports that this Illinois and Mississippi Canal was projected and built as a link of a waterway from Lake Michigan to the upper Mississippi River territories, the other link formed by the Illinois and Michigan Canal having been provided by Congress in the indirect manner noted, the assumption being that this canal would be maintained by Illinois in suitable condition for commerce; and because this Illinois and Michigan Canal was not properly maintained or improved after 1907, when the Illinois and Mississippi Canal was completed, the possible benefits from the latter have been practically nullified. The present project now being executed for the upper Mississippi River at a cost of $20,000,000 depends for a great share of its beneficial results on a suitable connection to Lake Michigan.

6. In addition to these money expenditures for actual construction, the interest of the United States in a waterway from Lake Michigan to the Illinois River is manifested by numerous surveys ordered by U. S. Congress. At the present time there is a special board considering the waterway from Lockport south. $1,000,000 is available for beginning U. S. share of the improvement when co-operation is assured.

7. The commercial importance of this route depends on its value (1) as a local transportation line; (2) as part of route via Hennepin Canal to upper Mississippi River, and (3) as part of a route via Illinois River to the lower Mississippi River. As to the general commercial advantages, Capt. W. L. Marshall, Corps of Engineers, reported in 1890 as follows:

'This route has invited attention as a practicable locus for a waterway between the Great Lakes and Mississippi River for many years, and its advantages have been so often reported to Congress that anything herein said would be mere repetition. It is sufficient to say that the minimum channel herein estimated upon will open a channel of commerce with a maximum annual capacity of 30,000,000 tons between the Great Lakes, with its terminus at their greatest port, and a system of navigable rivers penetrating one-half of the states and territories of the Union, with a total navigable length equal to more than half the circumference of the globe.' (Report, C. of E. 1890, p. 2452.)

It is understood that the law limits discussion of commercial importance of this route to references to records. It is not considered pertinent or necessary to discuss the fundamental question of the value of inland waterways in general.

8. While the above evidence may be considered sufficient to establish the fact that the United States has considered this route important as a portion of a waterway from the lakes to the Mississippi River, the question whether this fact leads to the procedure suggested of 'endeavoring to compel Illinois to spend moneys for maintenance of this canal,' is more complex. To determine this question it would seem necessary to arrive at some conclusion as to what is the proper project for this section of waterway, and if probable result of procedure suggested is in accord therewith. In this view brief reference will be made to the assets of the route, plans and recommendation that have been made by the Engineer Department, and the attitude of Illinois to this canal.

9. The assets of this route are the old right of way and the water powers.

10. As to the right of way, Major Riche reported on Jan. 24, 1904, on the 33 miles from Joliet to Chicago as follows:

'This right of way contains some 1,040 acres, which at $1,000 per acre would be worth $1,040,000. This valuation is based upon the cost of the right of way of the Sanitary Canal through the same territory, and is not believed to be excessive, especially in view of the ease and economy with which the line could be rendered available for railway purposes.'

On this same basis the total value will exceed 2¼ million dollars. The status of this asset and others pertaining to the canal and depending on U. S. grants would seem to be an essential factor to be considered in connection with any plan of future co-operation between Illinois and the United States.

11. As to the value of water power, a special board reports:

'By modification in the project submitted by the former board that will be in harmony with its report, this board is of the opinion that 100,000 horsepower can be developed by the diversion of 10,000 cubic feet per second.

Under such circumstances it seems proper that the Federal Government should assume, in its dealings with the Sanitary District of Chicago and the State of Illinois, the principal beneficiaries, that the net horsepower developed by 10,000 cubic feet per second diverted from Lake Michigan should produce a revenue of $2,500,000 per year.

The board considers that the property owners along the canal and Illinois River are equitably entitled to the water power due to the natural flow alone of the Des Plaines and Illinois Rivers, and that any power which results from an added flow diverted from Lake Michigan belongs to the people of the United States and Canada.' (H. Doc. No. 50, 61st Cong., 1st sess., pp. 28 and 29.)

The actual amount of diversion allowed from Lake Michigan, and hence the actual value of this asset, depends on the case now pending in U. S. Court between the United States and the Sanitary District, and on future action of U. S. Congress.

12. Concerning this waterway numerous surveys and reports have been submitted to Congress. A list of these documents to 1905 is found on page 8 of report of latest survey, made in 1905 (H. Doc. No. 263, 59th Cong., 1st sess.) The plans prepared by the Engineer Department for enlarging the

old canal and for waterway from Illinois River to Lake Michigan of 7, 8 and 14 feet depth will be briefly noted.

13. In 1882 a plan was submitted for enlarging the Illinois and Michigan Canal to the dimensions adopted for the Illinois and Mississippi Canal. This estimate was $2,298,-919.15, of which $1,028,412 was for channel work from Joliet to Chicago River, leaving $1,270,503.15 as the estimate made then for enlarging canal not now replaced by the drainage canal. This estimate is based on 20 cents per cubic yard for earth excavation and $1.75 for rock, and provides for locks at a cost of about $28,000 each. (Annual Report, C. E., 1883, pp. 1776-7.)

14. In 1890 surveys and estimate were made for this waterway from Illinois River to Lake Michigan. The estimate for 8 feet depth was, in round numbers, $14,000,000 from Joliet to Lake via Sag route, and about $17,000,000 via Chicago River. Estimates for total waterway were:

Via Chicago River	$26,883,153
Via Sag route	23,885,400

(Annual Report, C. E. 1890, pp. 2433-4.)

15. In 1900 a special board prepared plans for waterways of 7 and 8 feet depth. The proposed route in both of these plans is as follows:

'From Utica to Marseilles in the bed of the river; thence around the Marseilles Rapids by canal; thence in the bed of the river to near *the mouth of the Kankakee; thence through the Illinois and Michigan Canal* (18.3 miles) *to the Joliet basin;* thence by canal to the Sanitary Canal at Lockport, and thence via the Sanitary Canal and Chicago River to Lake Michigan.' The project involves 12 locks and 2 dams. (Annual Report C. E., 1901, p. 3048 et seq.)

The estimate for the 7 feet depth is:

From Utica to near Kankakee River	$2,055,187
Enlarging 18.3 miles of Illinois and Michigan Canal below Joliet	1,215,904
Total, Utica to Joliet	$3,271,091

For 8 feet depth about 10 per cent. should be added.

The 4 locks to be provided in the enlarged Illinois and Michigan Canal are each 40 by 260 feet.

The stretch from Joliet to Sanitary Canal has been provided by Illinois, which reduces the original estimate from over seven million dollars to amount above.

16. In 1905 a special board prepared plans for a 14-foot

waterway. This report suggests that its plan can be altered to provide for development of water powers. (H. Doc. No. 263, 59th Cong., 1st sess.)

In 1909 a special board by direct act of Congress reported on value of water powers and if same can help defray expenses of improvement. This board finds value as $2,500,000 per year as above noted. No plan for development of power by the United States is submitted. Its development by Illinois is favored on conditions, stated briefly: that earnings shall be applied to sanitary canal and power works till same are reimbursed, then United States shall receive percentage of earnings; also that the Sanitary Canal shall receive percentage of earnings; also that the Sanitary Canal shall be made U. S. waterway. (H. Doc. No. 50, 61st Cong., 1st sess.)

17. The special board now in existence is to pass upon plans to be submitted by Illinois. The report of this board states:

'In accordance with this agreement' (U. S. Law 1822 and 1827) 'the State constructed the Illinois and Michigan Canal from Bridgeport to La Salle, and improved the upper portion of the Illinois River by the construction of locks and dams at Henry and Copperas Creek.

'For many years this waterway was a valuable transportation route, but in recent years the State has neglected it and failed to maintain it abreast of the needs of commerce. The work now proposed by the State in connection with the canal of the Chicago Sanitary District contemplates a waterway from Lake Michigan to Utica' (near La Salle), 'which although departing from the line of the old canal, substitutes a waterway more than sufficient for any probable navigation. This will in effect fulfill the original agreement between the State and General Government for this section and incidentally develop a water power which the State considers a profitable business investment.'

The report further states that with the transfer to the United States of the locks and the control of the new waterway thus created, so far as needed by navigation, and the locks and dams at Henry and Copperas Creek on the Illinois River, the obligations of the State of Illinois to the United States with reference to the maintenance of the Illinois and Michigan Canal may be considered as adequately fulfilled, and any equities of the United States in the rights of way and other properties of this canal should be transferred by the

United States to the State of Illinois. (H. Doc. No. 1374, 61st Cong., 3d sess., p. 9.)

18. It is to be noted that the above referred to surveys were ordered directly by Congress and that the question of advisability or worthiness of the project is assumed or evaded. On this question the Chief of Engineers comments on report of 1909 above, as follows:

'An estimate will also be made of the cost of an 8-foot channel from Lake Michigan to the Mississippi River at St. Louis, which later, in connection with the present 8-foot project for that portion of the Mississippi River between St. Louis and Cairo, will provide for a least depth of 8 feet from Lake Michigan to the mouth of the Ohio River. It is expected that these additional estimates will be ready for submission to Congress before its next session. The Chief of Engineers is not prepared to state definitely for consideration by Congress that the construction of either of these channels is desirable until after accurate estimates are made.'

The existing special board states: 'Considered as a business investment, a waterway of even moderate depth from Chicago to the Gulf is still more or less experimental.' (H. Doc. No. 1347, 61st Cong., 3d sess., p. 6.)

19. From the above quotations it is seen that there is no approved project for a waterway from Lake Michigan to the Illinois River; that is (1) the advisability has not been specifically adjudged by the Engineer Department, and (2) physical plans have not been approved. Any interest the Engineer Department has in the construction of this waterway must be based on its supposed advisability which rests on the same basis as does the advisability of the Illinois and Mississippi Canal, and of the Illinois River, all three of which taken together should be improved or abandoned. The latest Act of Congress authorizing the present special board assumes such advisability and provides for approval of plans. Until such plans are approved it does not seem consistent that the Engineer Department should urge any specific costly work. The Engineer Department has specifically investigated and recommended abandonment of the major portion of the old canal, and could not in justice urge enlargement except of the 18.3 miles on Joliet end of canal, without full technical investigation leading to reversal of the previous recommendations of various boards and officers.

20. As to the question whether the canal, considered as an investment, and omitting its general benefits, has been a

burden to the state, the dissenting opinion in the Burke case in 1904 is specific on this question of fact as quoted by Major Riche, Jan. 24, 1907:

'The fact should not be lost sight of that the canal thus far has not been a burden to the state, and the evidence in this record does not show it ever will be burdensome to the state. The original cost of the canal, which was approximately $5,000,000, was paid for from the sale of lands donated to the state by the General Government for canal purposes, with the express understanding *that the canal should be forever maintained by the state.* From the time of its construction to the time of the filing of this bill the canal had earned more than $6,500,000, and there now remains in the state treasury, after paying all its expenses and after refunding to the state all monies appropriated for its use, the sum of $338,695.76.' (Burke v. Snively et al., Supreme Court of Illinois, 1904,—Illinois Reports, Vol. 208,—Phillips. Full copy enclosed with my report of the 10th inst., 33,-152/14.)

21. It seems worthy of note that the Illinois and Michigan Canal during the years of its successful operation was of benefit to the people of the State of Illinois chiefly, and aside from the returns (tolls, etc.), it is noted by the report of one board that the easily estimated direct saving in freight was over $2,000,000 for five years (Annual Report, C. E. 1887, p. 2128 et seq.). The primary intention of Congress in regard to waterways is to accommodate interstate traffic. Now, that the second canal has been provided, any further benefits that might accrue, if the Illinois and Michigan Canal is maintained in suitable condition, would be distributed to the people of more than one state, under which condition the expenditures previously made for the canal by the United States will be justifiable. It appears that of late years the annual income has not been sufficient for maintenance and the necessary betterments. It is pertinent to inquire what the state has done or failed to do to cause this falling off of commerce. Discriminating railroad rates have been allowed. The canal was not kept abreast of the needs of commerce even when its income was sufficient. A railroad treated in a similar manner would have failed.

22. The history of the proposed transfer of all or part of this canal is briefly as follows: In 1882, the legislature of Illinois passed an act ceding the canal to the United States under certain conditions. A board of engineer officers appointed to consider the proposition reported:

'The Board then presents the following reasons why the United States should not accept the cession of the Illinois and Michigan Canal under the conditions of the existing act: (1) The canal should not be enlarged upon the whole of the present line; on the contrary, it would be judicious to abandon the greater portion of it. (2) The act does not provide for the cession to the United States of that portion of the Illinois River improvement now owned by the State of Illinois, and which forms an essential part of the through line.

'3rd. The act is not sufficiently definite as to the obligations which the United States would assume in accepting the transfer of the canal.

'Although the Board is of opinion that the United States should not accept the canal under the existing conditions, it is further of opinion that the water-route of which the canal forms a part should be controlled by the General Government, and that acceptance should promptly follow a proposition to transfer it under conditions so modified as to remove the objections stated.' (Annual Report C. E., 1887, p. 2160.)

23. In 1907 a bill was introduced in U. S. Congress, H. R. 24271, 59th Cong., 2d sess., whereby the United States was to cede in *toto* all rights to right of way from Joliet to Chicago River to the State of Illinois, who was to transfer same to the Sanitary District of Chicago. This bill was reported on unfavorably by the district engineer officer because the transfer gave away valuable rights as to right of way and water power, which the United States should hold until a waterway was built to the Mississippi River.

24. The object, authority, and responsibility of the United States is to secure a suitable waterway from Lake Michigan to the Mississippi River. By direct appropriations such a waterway has been or is being provided for portions of the route. For the section of the route from the Illinois River to Lake Michigan, U. S. Congress attempted to reserve the right of way in 1822. By default of Illinois this attempt became void. In 1827 Congress provided for this section by the indirect means of land grant to Illinois. When the canal's traffic was profitable the State of Illinois used it as a money-making machine; she failed to properly improve it; and it has practically fallen into decay and consequent disuse. Such a history of the canal under state control is natural and to be expected, when we consider that commerce, and especially interstate commerce, is not a state's prime care, but that numerous other needs absorb a state's

funds and governmental concern. The state's interest in this canal has heretofore been measured by the money returns she received and a little short thereof. The proposed transfers of all liabilities to the United States, the state keeping the assets, denote this same interest. The present status of this Burke case displays this same attitude. Illinois by her constitution, as interpreted by her Supreme Court, estops herself from properly maintaining this waterway, but she keeps the assets that are perhaps worth over two million dollars, instead of ceding them back to the United States. On the other hand, Illinois has built the drainage canal. Although built primarily for local interests, which properly bore the burden of its cost, its value for navigation is great, the estimate of 1890 for an 8-foot channel from Lake Michigan to Joliet being over 14 million dollars.

25. This very natural attitude of the states is presumed to be the main reason why the United States was given the authority and responsibility concerning waterways for interstate commerce. It would seem that failure to assume this responsibility and authority has resulted in the confusion and lack of progress in this case. The simplest and only direct and apparently satisfactory policy by which this waterway can be handled is believed to be the general plan usually pursued: (1) for the United States to decide if it is advisable; (2) then prepare plans that destroy no assets and include water powers; (3) appropriate necessary money for the work; (4) condemn dam sites, etc., and complete the work; (5) and then determine the ownership of the assets. It seems clear from the above history that if a suitable waterway is ever built from Lake Michigan to the Mississippi River, the cost borne by the United States will be the total cost, lessened only by all or part of the value of the assets that pertain to the route. Inasmuch as the main assets—that is, the old right of way and the water power due to the flow permitted by the United States from Lake Michigan—are believed to belong to the United States, it is not seen what the United States can hope to gain by co-operation. Whether or not these assets are turned over to Illinois in return for total or partial construction of a waterway or are realized in some other manner is of more interest to Illinois than it is to the United States. However, as the latest act of Congress on this subject provides for continuation of co-operation, the attitude of the department must be to assist this

attempt and if possible force it to a climax of execution or failure.

26. Effect of proposed procedure is foreshadowed in prior decision in this Burke case, from which is quoted the following extract from decision of Supreme Court of Illinois—Illinois and Michigan Canal:

'The question whether the *cession of* Congress, and the acceptance thereof by the state, constitute a contract on the part of the state to forever keep and maintain the canal in such condition that the general government may use it as a public highway does not arise for determination. If such a contract arose out of the grant of the land and the acceptance thereof, the complaint that the provision of the state constitution here under consideration, if construed to deny to the legislature power to appropriate any sums whatever from the public treasury for the purpose of repairing or maintaining the canal in usable condition as a public highway would impair the obligation of that contract, cannot be urged by the appellees, who appear in the suit only in their capacity as officers, which positions they hold under and by authority of the constitution of the State of Illinois and the statutes made in pursuance thereof. The rights of these appellees are not affected by any alleged impairment of the alleged or supposed contract between the Federal Government and the State of Illinois. The only person who may complain that a law impairs the obligation of a contract is one who has an interest in the enforcement of the obligation of the contract said to be impaired. (Templeton v. Horne, 82 Ill., 491; 15 Am. & Eng. Ency. of Law, 2d Ed., 1059.) If it shall be found that the grant of the lands and the acceptance thereof constitute a contract, and a question of the enforcement of the contract shall arise, the United States and the State of Illinois, in the exercise of the sovereign power which they respectively possess, it may be confidently asserted, will adjust their respective rights and obligations amicably, honorably and justly. No obligation will be impaired or repudiated. The appellees are but servants of the state, charged temporarily with the performance of duties in and about certain public affairs of the state which the state has intrusted to them to be performed, and in that capacity they appear in this proceeding. They do not represent the United States and have no power to submit for decision the question whether contract obligations accrued by reason of the cession and acceptance of the lands, much less to insist that, notwithstanding the changed conditions which have, it seems, ren-

dered the canal wholly unnecessary, if not entirely useless, as a highway to the United States, the alleged contract can only be discharged by the specific performance thereof.'

Burke v. Snively.

Richard E. Burke v. Clarence E. Snively et al., opinion filed February 17, 1904; rehearing denied April 7, 1904.

27. It is therefore assumed that the effect of the United States appearing in this case will be to establish (1st) the contention that there is a contract between Illinois and the United States, and (2d) the nature of this contract, whether it is (a) a narrow contract requiring specific fulfillment by enlarging this canal, or (b) a broad contract to provide a suitable waterway from Lake Michigan to the Illinois River. If the ruling be that the contract is a narrow one (a), it is believed that any attempt to enforce it will be, in fact, futile. The required dimensions of the canal are nowhere specified and it would seem that these dimensions must hereafter be determined, as they have been heretofore by Illinois. If the ruling be that a broad contract exists, the obligation resting on Illinois will not be lessened, but may be met by (1) specific fulfillment—enlarging old canal—or (2) otherwise providing a waterway, and such a ruling by her Supreme Court should have the effect of causing Illinois to decide promptly how this acknowledged obligation would be met. Illinois' self-inflicted paralysis in this case is perhaps more technical than it is intentional. She has the undoubted right to maintain this canal or not, according to her judgment on costs and benefits, but in case she refuses to maintain it, its forfeiture should be considered. It seems plain to me that Illinois has already forfeited this canal, but as its possession by the United States will be of no value except appropriation be made for a waterway along all or part of it, it seems advisable to help Illinois into condition so she can decide this question one way or the other, and decide it by a body capable of carrying out her decision either (1) by appropriation for maintenance of old canal or otherwise providing a waterway, or (2) by forfeiture. The general effect of the proceeding suggested will simply be to determine that the legislature of Illinois may decide whether this canal shall be maintained. The pending test case is concerning an appropriation of $50,000 made by the Illinois legislature for this canal. The enlarging of the whole canal is not the issue. The issue is the legislature's right to enlarge the canal and the obligation to do so or forfeit it, or adopt another

plan. The enlargement of part of this old canal is part of another feasible plan. The establishment of this right and obligation is important to the United States as a factor in present negotiations for co-operation, or if co-operation fails, as a factor to be considered in connection with advisability and possibly reduced total cost of execution of this work by the United States.

28. In order to consider further the effect of procedure suggested, it is assumed that the first result will be to establish the contention that there is a contract and that the nature of the contract will be left mainly to the decision of Illinois. The question will then arise as to how she can carry out her obligations. As the physical plan of the work would seem to require the approval of the United States it would seem that approval could properly be given (a) to a project for enlarging the old canal; (b) to a project for a deep waterway now under consideration by the special board and the State of Illinois; or (c) what might be called a composite plan, which is a modification of the plan prepared in 1900 'for 7 or 8 feet depth by old canal from Joliet for 18.3 miles to below the mouth of Kankakee River; thence in river bed.' The modification suggested being that the section of waterway in river bed be adapted to the Illinois plan for developing power; that is, that the two dams below Morris be located to properly develop the power. This plan would provide for navigation and could further be modified by the earnings of the two dams being applied to the construction of the two dams above Morris and changing the navigation route from old canal to the river. This plan would seem to offer the best chances of immediate results and embraces no feature disapproved by the department. This plan is proposed because at the present time the Sanitary District is apparently attempting to build a power dam just below the state dam at Joliet. Such a dam would be of no benefit to navigation, as would a dam below Morris.

29. It appears to me pertinent to submit to the department my impression as to why this question has been submitted to the United States. I think that it is primarily a local controversy between the Illinois and Michigan Canal Commissioners and the Sanitary District and others. Apparently the difficulty of deciding who shall spend the 20 million dollars authorized by the people of Illinois is the reason which delays action of the legislature, and I do not

think it is the business of the United States to take sides in this controversy, but only to use its every effort to force some kind of a decision. The compromise, or modification of plan of 1900, suggested, may be satisfactory to all parties. The cost of this plan would be about $10,000,000. Over $1,000,000 would be spent in enlarging the 18.3 miles of old Illinois and Michigan Canal. If this plan is approved by the department and could be presented to the governor of Illinois in verbal conference with the Secretary of War, or in some other manner, he might decide to submit it to the legislature of Illinois as a means of securing immediate results and incidentally saving $10,000,000. A decision in pending suit, favorable to the U. S. contention would permit Illinois to choose this plan. At the present time she is prohibited from such choice. If this plan is chosen the $50,000 now appropriated by Illinois could be used without loss, on section of canal (near Joliet) included in plan.

30. As there is an inherent element of futility in any attempt to coerce a state and the results may be only indefinite delay, such attempt is, in my opinion, justified only when it is part of a definite plan which includes action to prevent such delay or to be followed in case of such delay. It is therefore assumed that so far as the engineer department is concerned it has determined on such a definite plan, including proper time limit for attempt and alternate action. My recommendations are based on this assumption.

In this case the time allowable would seem to be the time that under existing laws is necessary for the state legislature to be assembled and to consider this question. The alternate action might be submission of the whole question to Congress with definite conclusion as to (1) advisability and (2) physical plans; and definite recommendations either to (a) abandon this waterway and its allied connections, or (b) appropriate $10,000,000, more or less, for construction of waterway and utilization of assets, providing for immediate necessary condemnation and subsequent settlement of legal questions. Such a definite attitude of the Engineer department is justified because of the present deplorable condition. Many millions of dollars, spent on recommendations of the engineer department, are practically wasted unless this waterway is built.

31. It is recommended that, in the case now pending, the United States appear and assert that there is a contract between Illinois and the United States, and further assert

that the specific performance by maintaining the old canal is the only mode of fulfillment ever adopted by Illinois and cannot be abandoned until some other mode is fully provided for unless the whole contract is abandoned and final settlement made with the United States. It is further recommended that Illinois be informed of the opinion of the War Department as to the other plans that are considered sufficient to fulfill the obligation of Illinois. Such opinion as to deep waterway plan is printed in report of existing special board above quoted. A modified plan, based on plan of 1900, is above referred to; if this plan is approved by the department, Illinois should be so informed.

(Signed) H. B. Ferguson,
Major Corps of Engineers.

7 inclosures."

Mr. Shenehon: The government also offers in evidence hydrograph of United States Lake Survey similar to U. S. Exhibit Number 5, but extending the monthly mean elevations of the lake surfaces up to and including November, 1914.

The monthly mean elevations of the water surfaces of Lake Superior at Marquette, Lake Michigan at Milwaukee, Lake Huron at Harbor Beach, Lake Erie at Cleveland, Lake Erie at Buffalo, Lake Ontario at Oswego, for the year 1913, and a portion of the year 1914. Also monthly mean elevations of the St. Lawrence River at Ogdensburg for September and October, 1913. This is an official document of the United States Lake Survey.

Extract from the official report of Mr. W. S. Richmond, U. S. Junior Engineer of the Lake Survey, dated May 19, 1911, beginning line 8, page 51, as follows:

"As a basis of comparison of these measurements with those of former years, and of study of their internal consistency, the discharge formula derived by Assistant Engineer Thomas Russell, in 1904, corrected for more recent levels to the St. Clair Flats gage, has been used. It is

Q=197,065÷35,145 (Fort Gratiot—580.52)—20928 (St. Cl. Flts.—578.18).

All discharge measurements were corrected by the quantity, 20928 (St. Cl. Flats—575.18). From each result was subtracted the quantity, 197,065÷35,145 (Ft. Gratiot—580.52) and the resulting residuals reduced to percentages of the latter quantity.

Also extract from same report, beginning on the 6th line from the bottom of page 53, as follows:

"Plate 8 shows the measurements of 1908, 1909 and 1910, corrected by the quantity, 20,928 (St. Clair Flats—575.18), plotted with respect to Lake Huron elevation at the shore position of Ft. Gratiot gage. Each plotted point represents the mean of five measurements grouped in order of lake stage. In four or five instances, a mean of 3, 4, and 6 measurements was used instead of 5."

Plate 8 referred to in this extract is Defendant's Exhibit 23 (Vol. VII, p. 138).

Extract from Appendix 3 of the Annual Report of Lieutenant Colonel G. J. Lydecker, Corps of Engineers U. S. Army, for the fiscal year ending June 30, 1900, page 5320, as follows:

"In my last annual report (page 3854, Report Chief of Engineers for 1899) I stated that we had found indications of a marked deepening since 1867, in the channel of the St. Clair River just below its head, and it was thought that this might have caused a material change in the outflow from Lake Huron during recent years; but further careful investigation shows clearly that there has been no such change in the regimen of the river. It also shows the great danger of jumping to conclusions in matters of this kind, and suggests the propriety of avoiding an expression of opinion on any important point until all the facts in the case are positively ascertained."

Also extract from the report of Assistant Engineer E. E. Haskell, same volume, page 5323, as follows:

"In my last year's report I called attention to what seemed at that time a clear case of enlargement, by scour, of the head of the St. Clair River. A preliminary survey of this reach was made by Mr. Sabin in December, 1898. The results of this survey, when compared with the chart of the survey of 1867, showed what seemed to be a cutting out of the river bed to a depth of about 18 feet greater, for an area covering a portion of the gorged reach. Upon the strength of this evidence I made the statement that appears in my last Annual Report. Early last fall Mr. Sabin called my attention to the fact that the survey of 1859 of this reach, as charted, agreed much closer with present conditions than did the survey of 1867. It immediately occurred to me that it would be well to secure the original field notes of the surveys of 1859 and 1867, and replat them on the same scale as

the detailed survey made last fall, and then compare the three surveys. Accordingly, the old notes were obtained and the surveys of 1859 and 1867, platted anew on the scale of 1:5,000, putting on all soundings taken. Tracings of these new plats were sent to Mr. Sabin and he was requested to make a very careful comparison of these with the results of his recent work. He has accomplished this, and discusses the matter very carefully in his report. His conclusions are that the changes that have taken place are small, that between 1859 and 1867, the most restricted cross section may have enlarged about 9,000 square feet, and that the line of deepest water may have moved a little westward; that between 1867 and the present time the changes, if any, are unimportant. What seemed at the outset, therefore, as a reasonable explanation for the low stage of water in Lakes Huron and Michigan, culminating in 1895, is set at naught, and we must return to the question of rainfall and evaporation for new data for a satisfactory solution."

Extract from the Report of Assistant Engineer L. C. Sabin, beginning page 5393 (1900), omitting tables 20, 21, 22, and all plates, as follows:

"FALL FROM LAKE HURON TO LAKE ERIE.

"In considering the total fall in the channel connecting Lakes Huron and Erie we are fortunate in having a series of water levels for the two lakes extending over a period of forty-five years without interruption. We have also a series at the St. Clair Flats Canal, 1873 to date, excepting the years 1879 to 1882; a series on the Detroit River at the lighthouse depot from 1867 to 1881; and a short series on Detroit River from 1861 to 1866, published in the report of Chief of Engineers for 1868. A series on the Detroit River made by the officials of the Detroit water works from 1853 to 1898, with the exception of 1860 to 1865, when only high and low stages were recorded, is also at our disposal through the courtesy of Mr. C. W. Hubbell, civil engineer to the Board of Water Commissioners of the City of Detroit.

"(Table No. 20.)

"In presenting a summary of these water levels in table number 20, only the months that are entirely free from ice have been considered, and the result for each year is the mean of the levels for the six months, June to November, inclusive. In order to obtain a continuous record of the fall in St. Clair River alone, the level of Lake St. Clair for the several years when no record was kept at the St. Clair Flats

has been deduced from the Detroit River readings by adding 0.44 foot, which is the mean fall from the Flats to lighthouse depot for six years when records were kept at both places. The results for Lakes Huron, St. Clair and Erie are shown on Pl. XVI. (It may be well to again call attention to the fact that the fall from the flats to Detroit is in reality 0.378 foot greater than shown by this table, the precise level line of 1899, having shown that discrepancy in the levels carried to New Baltimore from Port Huron at the head of St. Clair River, and from Gibralter, at the foot of Detroit River; but as this discrepancy occurs between Windmill Point and New Baltimore, it affects only the fall in Lake St. Clair.)

"The table shows clearly that since 1888 the fall in St. Clair River has been less than in former years, and the mean results for several groups of years are shown in the following table:

Number of years	Period	Mean elevation Lake Huron	Mean elevation Lake St. Clair	Mean fall.
17....................	1855-1872	581.81	576.36	5.45
16....................	1873-1888	581.92	576.33	5.59
11....................	1889-1899	580.23	575.17	5.06

"This change in fall in the St. Clair River has been attributed to a supposed change in regimen through the gorge at the head of the river, and since this opinion has been given some publicity it may be well to consider the question in some detail. In December, 1898, a cursory survey of the narrowest section of the river was made in accordance with your orders, and in 1899 the conditions at the head of the river were carefully developed. The results of this survey are shown on Plate I. The individual soundings are not shown on this plate, but the area was thoroughly covered, and the conditions are better represented by the submarine contours ten feet apart. The successive cross-sections of the river will also assist in bringing out the form of the channel. The 60-foot submarine contour extends from a point opposite the lighthouse to a little below section 'Arthur,' some 3,200 feet. Within the northern half of this area there is a very narrow 70-foot area about 1,400 feet long. To the westward of this area there is a shoal with a minimum depth of about 22 feet. Between this and the American shore there is a narrow channel having 36 feet of water, the 30-foot curve running up above the lighthouse about 400 feet. Between sections 'Culvert' and 'Fish' the shoal runs out, and the two channels merge in one. These characteristics are clearly brought out by the contours and cross-sections.

"Two surveys had previously been made of this locality,

one in 1859 and one in 1867. The soundings shown on the map of the 1859 survey are apparently accurately located, and in general they agree very closely indeed with the results of our recent survey. The only changes apparent since 1859 are as follows: The 70-foot area appears to have been extended about 700 feet downstream, with a width of only 50 feet. It may also have shifted to the westward a little, and the deep channel near the west shore may have diminished in width. If these changes are real the area of cross-section at the immediate head of the river remains about the same, all lines having been shifted a little to the westward. In the vicinity of section 'Arthur' but few soundings are given on the 1859 map, but it appears that the 50-foot and the 60-foot contours may have been extended downstream about 600 feet each, the 60-foot contour having terminated in 1859 about 400 feet above section 'Arthur.' The width of this section has apparently been reduced about 50 feet since 1859 by the building of docks. Below section 'Stauber' the sounding plotted are so infrequent that no definite conclusions can be drawn, though it appears that the deep-water areas have moved to the west, toward the concave bank, and a possible deepening of five feet may have taken place over small areas.

"The survey of 1867 is by no means as satisfactory, although a large number of soundings are available. The method followed seems to have been to sound on lines between shore stations without locating any of the soundings. This renders the actual location quite indeterminate. To distribute the soundings along the lines equidistant does not make the lines consistent with one another, and is indeed a very improbable distribution, considering the existing currents. A reasonable distribtuion can be made which will agree almost perfectly with present conditions, and any distribution which can be made establishes the fact that the 60-foot curve has not been extended since that time. In the central channel east of the lighthouse two 66-foot soundings were obtained in 1867 which agree with the present depth; to the westward appears the shoal, and the deep channel with 36 feet of water nearer the shore. There are four soundings of 60 feet at about section 'Fish,' one above section 'Arthur,' and one just below this section, which is the present limit of the 60-foot curve. No 70-foot soundings were obtained in 1867, but since the 70-foot area existed in 1859. as at present, and since only one line of soundings crossed this area in

1867, at a point where it exceeds 50 feet in width, it is not strange that it was missed.

"Although the data furnished by the previous surveys are imperfect we may conclude that between 1859 and 1867, the area of cross-section of the river at the most restricted point may have increased in area about 9,000 square feet for a length of about 60 feet, the 50-foot and 60-foot contours having been extended downstream about this distance. It also appears that since 1859, the deepest channel may have moved a little to the westward or toward the concave bank. There is no evidence of any important changes in area above section 'Arthur' since 1867, and it is quite certain that the limits of the 60-foot depth have not been extended downstream since that time. Below this section the depths may have increased a few feet over narrow areas.

"As to the effect of the extension of the 60-foot curve between 1859 and 1867, if the restricted cross-section acts as a submerged weir, its effect would be quite important, but if it is considered simply as a portion of the stream the effect on the slope would be very small. The mean fall in the St. Clair River from 1861 to 1867 was about three-tenths of a foot less than the fall from 1855 to 1859, but the level of Lake Huron had also fallen, and when the Huron level was restored in 1876 and 1886, the high slope was again found.

"Since the mean annual fluctuation of the water surface of Lake Erie is greater than that of Lake Michigan-Huron, the conclusion has been drawn that in high stages the slope in the connecting channel is low and that in low stages the slope is high. While, as will be shown, this is partially true as regards the seasonal changes in stage, and can easily be explained, it is an entirely erroneous conclusion as applied to years of high and low water. On the contrary, when we consider a term of years, it is found that the relation of stage to slope is well marked, though subject to occasional variations, as in the case of the fall at the head of the river.

"The relation of the fall in the St. Clair River to the level of Lake Huron is brought out on Plate XIV, fig. 1, in which the elevation of Lake St. Clair is plotted with reference to the stage of Lake Huron, the 6-month mean values for June to November being used. (Table No. 20.)

"Since the question under consideration is whether a permanent change in the slope of the river occurred about 1888, due to changes in regimen at the rapids, we will consider

the relation of slope to stage for the two periods before and after the supposed change. We have therefore computed by the method of least squares the relation of the level of Lake St. Clair to that of Lake Huron for thirty-three years, 1855 to 1888, excepting 1860, when no levels are available. The equation expressing this relation is found to be

"Lake St. Clair=574.32+0.707 (Huron stage—579)—— (eq. 1)

expressed as relation of fall to Huron stage this becomes

"Fall in St. Clair River=4.68+0.293 (Huron stage—579) (eq. 2)

"That is, a rise in Lake Huron of 1 foot occasions an increase in fall of about 0.29 foot. While this relation is by no means fulfilled at all times it represents, as nearly as the data will allow, the normal condition existing from 1855 to 1888. Treating the eleven years, 1889 to 1899, since this change in regimen is said to have taken place, in the same manner, we find the equation—

"Lake St. Clair=574.20+.788 (Huron—579) or —— (eq. 3)

"Fall in St. Clair River=4.80+.312 (Huron—579)—(eq. 4)

"The difference between the equations (2 and 4) is in the wrong direction to indicate an enlargement of section, but this is of no consequence, for it is too small to indicate any change in area; it is due simply to the fact that Lake Huron is not the only factor controlling this fall, and it is only by taking a long series of years that we may arrive at the normal relationship.

"Having established as far as possible by this method that there has been no change in hydraulic conditions in recent years, we may now determine the equation which most nearly expresses the relation of fall to stage for 44 years' observations, and this is found to be:

"Fall=4.67+.30 (Huron—579).

"On Plate XIV, fig. 1, the straight line represents the relation of the elevation of Lake St. Clair to Lake Huron as deduced from this equation. In Table No. 21, the elevation of Lake St. Clair is computed by this equation for each year, and the results are given in column f, the computed fall is given in column g, and the error of the computed value for each year appears in column 8. It is seen that the computed values are in error as much as 0.30 foot in three years, but for thirty-three years the error is less than 0.20 foot.

(Table 21.)

"The effect of Lake Erie on the elevation of Lake St. Clair has not thus far been considered, as in the preceding equa-

tions the fall in the St. Clair River is made to depend upon the elevation of Lake Huron alone, while Lakes Huron and Erie generally rise and fall somewhat in unison on account of the similar climatic conditions and the partial control of Erie by Huron; yet they do not always act together. From 1865 to 1866 Huron fell 0.3 foot, while Erie rose 0.15 foot, and from 1866 to 1867 the reverse occurred. At such times Lake Erie must have an independent effect on the level of Lake St. Clair, and from the results of 44 years' observations we may obtain the equation expressing the elevation of Lake St. Clair in terms of the elevation of Huron and Erie as follows:

"$C=576.05+.407\ (H-581.46)+.452\ (E-573.09)$ — — (6)

where C is the elevation of Lake St. Clair above mean tide and H and E are the elevations of Lake Huron and Erie, respectively. By a simple transformation we find the fall in St. Clair River

"$f=4.67+.593\ (H-579.0)-.452\ (E-571.50)$— — — (7)

"In Table No. 21, column k, the difference between the observed fall and that computed by equation (7) is given for each year, and it is seen that these residuals are in general very small. The greatest error of the computed fall is 0.28 foot in 1883. There are ten years in which the error exceeds 0.1 foot and but five years when it exceeds 0.2 foot. This equation then expresses very closely the relation which has existed between the level of Lake St. Clair and that of Lakes Huron and Erie for forty-four years, and indicates that the level of Lake St. Clair is so nearly controlled by the lakes above and below it that its local supply can have little effect on the variations in its annual mean level, though it may affect its monthly mean, as will appear later.

"On Plate XVI, the computed and observed elevations of Lake St. Clair are shown by the two curves, and the correspondence is thus brought out graphically. The full line represents observed elevations and the dash line shows the computed values. Had a pronounced change in regimen taken place at the head of the river between 1886 and 1888, such as an important scour at the rapids, the same equation would not express this relationship before and after the change, because the fall in the St. Clair River would have been less for a given discharge after the scour; yet it is seen that the computed and actual elevations of Lake St. Clair are in very close agreement from 1868 to 1882, and from 1885 to 1899.

"Neither is the present low fall in the river unprecedented, for in 1866 it was lower than in the past three years, and dur-

ing the five years, 1864 to 1868, the mean fall in the St. Clair River was but 0.1 foot greater than in the past five years, although the stage was about a foot higher. During 1847 and 1848 the level of Huron was as low as at present. According to the published record the mean fall from Huron to Erie for the four months of May and October, 1847 and 1848 (the only months for which we have the Erie record in these two years), is less than seven feet, and the result at the waterworks in Detroit for the only one of these months when we have a record is consistent with the record for Erie.

"We have thus shown, first, that the surveys furnish no evidence of a change in the regimen of the St. Clair River since 1867, though they indicate that a small permanent change may have taken place between 1859 and 1867; second, that the water levels indicate that no permanent change of importance has taken place in the conditions governing the slope in the St. Clair River; and third, that the present relative elevations of the lakes is not unprecedented, and hence that there is no reason to suppose that, as far as natural conditions are concerned, the level of Lake Huron will not return to its normal stage.

"The fact still remains, however, that the mean level of Lake Huron for the past ten years is about 1.70 feet below the mean for the preceding thirty-four years, while Lake Erie is but one foot below that mean. As to the reason for this condition, it is possible that the improvement of the channel of the Detroit River may have had a slight effect, certainly not exceeding 0.2 foot. Considering the lower lake system as a whole, there is little question that the deficiency in precipitation in the recent years is sufficient to account for the present levels, and without going into this question of precipitation and evaporation, it may be said that it is quite possible the deficiency of the former and excess of the latter for Lake Michigan-Huron as compared to Lake Erie might be sufficient to account for the lower level of Lake Huron. But since the climatic conditions on the two lakes are usually similar, to attribute this difference in level to a change in this respect will not carry much weight unless established by an analysis of the existing data.

"There is a possible explanation of the question, however, which does not involve any changes in channel depth or differences in climatic conditions between the two lakes. It makes the present low water of Lake Huron depend upon natural causes which may be removed, and if at this time the

precipitation return to the normal the lakes will return to their usual stage.

"The effect of changes in slope at the head of St. Clair River upon the discharge from Lake Huron has been mentioned above, and it has been shown that a decrease in fall of 0.01 foot in 4.4 miles between G. T. R. and dry dock may occasion a decrease in discharge of approximately 1,200 cubic-foot seconds, this value having been determined by two measurements of discharge in December, 1898, when the water was backed up by ice, one of these measurements having shown a discharge of 47,600 cubic-foot seconds below the normal when the fall was 0.39 foot below that corresponding to the stage.

"During the past winter the water levels taken at Sand Beach and mouth of Black River gave the following results:

Month	Sand Beach	Black River	Fall	Normal fall without ice effect.	Difference.
January	579.38	578.52	0.86	1.20	0.34
February	579.38	578.79	0.59	1.20	.61
March	579.42	578.76	0.66	1.20	.54

"Assuming a decrease in discharge of 1,200 cubic-foot seconds for each 0.01 foot decrease in the fall at the head of the river, we derive the effect of ice on the discharge as given in the table below, and since a change in discharge of 10,000 cubic-foot seconds is equivalent to a depth of about 0.02 foot a month over Lake Michigan-Huron, we have the resulting storage as shown, which for the three months amounts to 0.36 foot:

Month.	Fall diminished by ice.	Corresponding decrease in discharge.	Storage depth.
	Feet.	Cubic-foot seconds	Feet.
January 1900	0.34	40,800	0.082
February 1900	0.61	73,200	.146
March 1900	0.56	64,800	.130
Total, three months			.36

"That is, if we accept this reasoning, the level of Lake Michigan-Huron is, in the spring of 1900, 0.36 foot higher than it would have been if we had had no ice in the St. Clair River during the past winter.

"During the fourteen years from 1875 to 1888 there was a mean of twelve days each winter when the temperature, as recorded by the weather bureau at Port Huron, went below 14 degrees F. in December and January, while from 1889 to 1899 the mean number of days in these months when the tem-

perature went below 14 degrees was six. During the past winter there were eight days in December and January when the temperature went below 14 degrees. The formation of ice depends upon the occurrence of very low temperature lasting for several days, so that it may be estimated by the number of very cold days better than by the mean temperature. Judged by this standard then, it is reasonable to suppose that the ice effect has been much less during the past ten years than it had been during the preceding fourteen years.

"Let us consider how the formation of ice in the lower St. Clair River would affect the water levels in any given year. The discharge being greatly diminished, Lake St. Clair would tend to drain off into Lake Erie during the winter, and it would be lowered to such a point that the flow through the Detroit River would approximately equal the discharge through the St. Clair. The elevation of this point would depend upon the relative effects of ice upon the two rivers, but the effect on the St. Clair is usually much greater than on the Detroit. The total fall in the St. Clair would thus be increased, while that in the Detroit would be diminished. The difference between the diminshed supply to Lake Erie and the diminished outflow following the lower level would be shown by the greater total fall between Huron and Erie during the months of ice effect than would naturally exist without ice.

"In 1873 water-gage readings were started at St. Clair Flats Canal, and have been continued since that time, except that from 1879 to 1883 readings were omitted during part of each year. We have therefore taken out in one group the means of the months for Lakes Huron, St. Clair and Erie from 1873 to 1887, omitting 1879 to 1883, inclusive, and in another group from 1888 to 1899, inclusive. The resulting mean monthly falls are given in table No. 22, and those are shown graphically on Plate XVII.

(Table No. 22.)

"Comparing the results of the first ten years with the curves of the past twelve years, the greater effect of ice during the former period seems to be clearly shown. In the first place it is noticed that the mean annual range of Lake Huron has been increased from 0.9 foot, as in former years, to 1.03 feet, the winter months now showing a relatively lower stage. The St. Clair curve is very instructive. It shows that in the earlier period the water surface of Lake St. Clair fell rapidly

in January and February, when it was drained off into Lake Erie, while in later years the subsidence of level is but half as great. But these points are most strikingly shown by the mean annual curves of fall in the St. Clair River. The range in the mean annual curve of fall for recent years is but 3 inches, whereas the range in the mean curve in the earlier period was 8 inches. A reference to Plate XVII will show the disturbance in this slope between December and April, and the very much smaller disturbance in the past twelve years. The range in the fall of the Detroit River has not been changed, though in recent years the curve is smoother. The maximum fall is shown in December as before, but the minimum, which occurred in February, is eliminated, and only one minimum that of May, is shown in the mean curve of recent years.

"A word may be added here as to the cause of the condition already mentioned, that in the channel connecting Lakes Huron and Erie, the fall is greater in those months when the water level is receding. This is occasioned by the facts, first, that Lake Erie has a greater mean annual range in level than has Michigan-Huron, due in part at least to the effect of the supply to the former from the latter; and second, that the seasons are earlier on Erie than on Michigan-Huron. Comparing the mean annual curves of Huron and Erie it is seen that Erie reaches its maximum in June, and begins to fall while Huron is still rising. The Huron curve from July to October is almost identical with the Erie curve from June to September, that is, there is practically the same subsidence in the two lakes during the three months succeeding the maximum, but since Erie is about a month in advance, the fall in the connecting channel is increasing with a falling stage. As Erie reaches its maximum a month earlier than Huron, so is its subsidence checked a month earlier, and we have from November to April a generally decreasing fall in the connecting channel. Between March and April Huron rises slowly, but Erie, on account of its earlier season has a sharp rise in this month, causing the occurrence of the lowest fall of the year either in April or May. Thus we have a cycle of changes resulting in a low slope in the first half of the year and a high slope in the latter half due to seasonal changes, but, as has been shown, the slope in the high-water years is greater than in low-water years.

To return to the question of the effect of the ice on the relative levels of Huron and Erie, it has been shown that the wa-

ter levels give evidence of much greater disturbance of the natural slope during the winter months of the years from 1873 to 1878 and from 1884 to 1887 than during the winters of the past twelve years, and that, judged by the number of cold days in each winter, the recent years have been much less favorable for the formation of ice. The probable effect of the diminished slope at the head of the river caused by ice during the past winter has been shown to be more than four inches. While this effect may be overestimated in the foregoing table, there is no doubt that in the consideration of the effect of ice we are dealing with conditions which are very potent and that the lack of ice effect due to recent mild winters furnishes a plausible explanation of the present low water of Lake Huron as compared with Lake Erie. The conclusion seems to be clearly indicated that nature has provided a system of regulating works in the St. Clair River which she has neglected to use to their full capacity during recent years."

Extract from the Report of Assistant Engineer F. C. Shenehon on page 5332, as follows:

"The wetted perimiter of the bridge section as developed by the soundings is so broken and irregular, and the water is so perturbed and deflected by the bridge piers and by a caisson that escaped during construction and lies across a portion of span 6, that the validity of results derived from such a section may be questioned.

"A discussion of this point, however, points to an error to be expected from this source but little in excess of that of an open-river section. Let it be assumed that the eddies and boilings close to the piers make correct estimates of the flow impossible in areas extending for certain distances from them, and that the caisson lying across a portion of span 6 adds another uncertain area.

"The resulting indetermination as affecting the total volume of flow may be closely estimated as follows:

"Taking the doubtful regions as those portions of the cross-sectional area extending ten feet in spans 1, 2, 8, and 9 and 20 feet from the piers in the remaining spans; adding 300 square feet for the caisson, they are as follows:

	Square feet.		Square feet.
Span 1	90	Span 7	404
2	110	8	340
3	600	9	200
4	680		
5	900	Total	4260
6	940		

"This is about 10 per cent. of the total cross-section. With a velocity taken as half that of the mean velocity of the river the discharge in question is 5 per cent. of the total volume.

"It is not probable that the errors in estimating the flow in these 19 doubtful places will all have the same sign. In some the quantity will be taken too great and in some too small, so that the summation will balance error against error and eliminate a part of them. It will, therefore, be entirely safe to assign 10 per cent. as a maximum error in the sum of the partial discharges.

"With this liberal allowance the indetermination in the volume of flow of the full river, from this cause, is seen to be 10 per cent. of 5 per cent., which is but one-half of 1 per cent.

"In view of the small cost of gauging from a bridge as compared with open-river work the bridge section warrants the large excess of coefficient work necessary to place its results in comparison with those of a simpler section with unbroken flow.

"Regarding the final results, the checking of the volume of the discharge is more reliable because the two sections present conditions so different as to require independent methods of treatment for the determination of coefficients."

Extract from page 5343, as follows:

"The third element that enters into the substation coefficient is the direction coefficient.

"The direction of the current flow was not, as a rule, at right angles to the bridge, but at midspan the trend was 2 or 3 degrees to the eastward, and nearer the piers was deflected from them, so that for each opening the threads tended to converge in a vena contracta.

"The surface indication of the direction was taken as the direction at all depths, and the angle taken by a 20-foot line flush with the water surface, to which was attached a weighted float, while the upstream end was attached to the weight of the B meter lowered from the south side of the bridge just below the water, was accepted as a basis for direction coefficient.

"This was observed for all substations, and additional observations were put in around the piers.

"The influence of the direction element on the measured discharge is minute, almost negligible.

OPEN SECTION.

TABLE 5. INDEX VELOCITIES AS PERCENTAGES OF MEAN INDEX VELOCITY.

	Group No. 1.	2.	3.	4.	5.	6.	Total.	Weighted Means.
Number of observations in group elevation of.........	10	10	10	10	10	7	57	....
Lake gauge........	572.0	571.4	571.2	571.1	570.9	570.5	....	571.2
Mean index velocity	4.84	4.58	4.51	4.45	4.38	4.21	....	4.51
Station:								
1	42.6	33.9	28.4	23.5	25.6	29.2	....	30.6
2	81.3	79.0	78.6	77.6	77.3	77.2	....	78.5
3	95.9	96.8	97.7	99.7	98.8	97.6	....	97.8
4	104.5	105.1	105.4	106.0	106.7	106.2	....	105.6
5	126.6	127.8	129.3	127.9	128.1	126.6	....	127.8
6	129.2	130.5	133.1	133.0	134.4	136.1	....	132.5
7	124.1	125.1	126.1	126.4	125.6	125.7	....	125.5
8	121.3	122.9	124.6	124.9	124.5	123.3	....	123.6
9	118.2	121.1	120.5	121.4	121.6	122.1	....	120.7
10	108.9	110.5	110.3	110.4	110.7	112.4	....	110.4
11	107.7	110.6	110.7	111.9	110.8	110.2	....	110.3
12	106.7	107.6	106.9	108.6	108.3	109.5	....	107.8
13	92.6	93.5	91.9	92.7	91.2	91.9	....	92.3
14	100.0	99.8	99.3	99.9	101.0	98.8	....	99.9
15	92.4	90.9	91.3	90.4	91.8	90.7	....	91.3
16	84.1	84.3	84.6	84.2	83.7	83.1	....	84.0
17	64.1	64.9	61.4	62.1	61.0	59.9	....	61.8

Page 5347, the following table:

OPEN SECTION—MEAN VELOCITY COEFFICIENTS.

568.0		0.937	0.927	0.932	0.933	0.933	0.933	0.939	0.927	0.907	0.903	0.921	0.935	0.917	0.914	0.925	0.863
567.5	Volume	.9325	.9235	.9285	.9294	.9295	.9295	.9355	.9235	.903	.899	.9165	.932	.9145	.910	.918	.855
567.0	taken	.928	.920	.925	.926	.926	.926	.932	.920	.899	.895	.912	.929	.912	.906	.911	.848
566.5	from	.9235	.9165	.9215	.9225	.9225	.9225	.9285	.9165	.895	.891	.9075	.926	.9095	.902	.904	.840
566.0	table.	.919	.913	.918	.919	.919	.919	.925	.913	.891	.887	.903	.923	.907	.898	.897	.833
565.5		.9145	.9095	.9145	.9155	.9155	.9155	.9215	.9095	.887	.883	.8985	.920	.9045	.894	.890	.826
565.0		.910	.906	.911	.912	.912	.912	.918	.906	.883	.879	.894	.917	.902	.890	.883	.819

Extract page 5353, as follows:

"In investigating the form of the vertical curves, those of stations 1 and 17 were set aside as in too shallow water for developing the curve, and the remaining 15 were divided into three sets of five each of as near the same depths as possible.

"By dividing the discharge observations with all the high gages in one group and all the low-gage measurements in the other, and taking for each group the mean of the eight-tenths depth ratios, a percentage was derived for each mean stage, high and low. A similar treatment of the velocity ratios at the subsurface depth, 565, gave likewise two ratios.

"Taken in connection with the index, through which both curves must pass at ratio 1.00, the high-gage curve was defined by three points and the low by three points. The difference in the areas of the two curves divided by the depth indicated the extent of the variation of the coefficient.

"This matter will be taken up again later in a discussion of vertical curves in the light of the added high-water observations of 1900, and it may be stated now that the eight-tenths depth ratio showed little change for change of gage, the mean change in 15 curves for a gage movement of 1 foot being but a tenth of one per cent. At 565 the change amounted to an increase of 1.2 per cent. as the mean of the 15 station curves.

"The following summary shows the distribution of the ratio change:

Series number.	Number of observations.	Mean depth.	Stations in series.	Increment in ratio for feet rise in section gauge. Per cent.	Add to coefficient on this account for feet rise in gauge. Per cent.
1............	95	34	4, 5, 6, 7, 8	2.14	0.4
2............	91	28	3, 9, 10, 11, 12	1.36	.3
3............	83	17	2, 13, 14, 15, 16	.06	.0
Total.....	269	..	15	...	..
Mean.....	....	26.3	....	1.2	.2

"A second increment to the coefficient for rise of gage is due to the excess of the top feet percentage over the mean.

"Had the index been located at a percentage of depth instead of at an invariable elevation, the error of constant coefficient for the mean velocity percentage of each series would have been as follows:

"Indicated Error of Assumption of Constant Velocity.

"Coefficient When Index Is Taken at Percentage Depth.—

For 1-foot rise of gage: Series 1, constant coefficient would be 0.3 per cent. too small; Series 2, constant coefficient would be 0.3 per cent. too small; Series 3, constant coefficient would be 0.0 per cent. too small.

"Mean of 15 curves gives coefficient 0.2 per cent. too small, which is almost a negligible quantity. And so far as these observations go they tend to prove the proposition of fixed velocity relations at tenths of depth.

"An indication is given that a strong downstream wind speeds the upper strata more than those near the mid-depth, causing a slight reverse flexure to the vertical curve as it nears the surface. Two to three per cent. marks the extent of this departure from the curve of calm weather."

Extract from Appendix EEE, of Annual Report of the Chief of Engineers U. S. A. for the fiscal year ending June 30, 1901, report of Principal Assistant Engineer E. E. Haskell, page 3771, as follows:

"Our winter's work in the measurement of the discharge of this river will be of exceptional value. It has thus far been a matter of conjecture as to what effect the freezing over of the river had on the volume of outflow from Lake Huron. Assistant Sabin, in his annual report, called attention to this matter, and pointed out that, while dependent upon the weather, it might be large enough to materially affect the relative stage of water in the lower lakes. We are now prepared, or will be on completion of the reduction of our observations, to throw much light upon this matter. To anticipate our results: The temperature conditions of the early winter were such that by January 20, Lake St. Clair and the St. Clair River, from its mouth to a point above Stag Island, had frozen over. The foot of Lake Huron had also frozen over and what is familiarly known as the 'Ice Bridge' had formed at Fort Gratiot. This left open water from a point just below Fort Gratiot to a point some little distance above Stag Island. The fall between our Grand Trunk gage —near the head of the river—and the one at the mouth of Black River fell off about two-thirds. The open river above mentioned enabled us to continue discharge measurements as usual. Observations were made at Section Dry Dock until such time as floating ice enough had broken off from and run under the ice bridge to block the river from near Stag Island to a point above this section. A new section, called Craig, was immediately selected above the mouth of Black River where observations were made until the ice broke up near the

last of March. Almost immediately after the closing of the river in January, as above outlined, the discharge fell off approximately 50 per cent., and did not resume normal conditions of flow until the river became clear of ice about the middle of May. During the general breaking up of the ice, immense masses of it were forced into the river by northerly winds and so choked the flow that for a time but very little water could have found its way through. For some days Lake St. Clair was but a few inches above the level of Lake Erie. This condition of restricted flow has made itself manifest in the relative elevations of Lakes Huron and Erie, and we find that for the month just closed Lake Huron was 0.55 foot higher, while Lake Erie was 0.75 foot lower than during June, 1900. Here then is the explanation for the present low stage of water in Lake Erie, which will be thoroughly substantiated when the results from the complete reduction of our observations are ready for presentation."

Extract from the Report of Assistant Engineer Francis C. Shenehon, page 3773, as follows:

"These objections prevailed and a new section just above Point Three Points was tested. This showed a maximum velocity of about 5.5 feet per second, with a midstream depth of 60 feet and a width of 1,686 feet between terminal crib locations.

"The stream approaches this section from a long, straight course. It is free from 'boilers' and eddies."

Extract from report of Principal Assistant Engineer E. E. Haskell, for 1902, being included in the Report of the Chief of Engineers, U. S. Army, for 1902 (pages 2777-8), as follows:

"January shows a loss of discharge of 13,500 cubic feet per second; February a loss of 21,650 cubic feet per second, and March a loss of 13,080 cubic feet per second. The April indication of the Oswego gage shows too great a discharge by 3,195 cubic feet per second. The mean loss of flow for these four months spread over the whole year is about 4,280 cubic feet per second. For the month of February—the month of intense cold, when the upper river is frozen over, the loss of outflow is seen to be about 10 per cent. The loss is shown to be mainly accounted for by the increased slope in the river above the Galops Rapids, Table 22a. For February the slope from Ontario to Galops is shown to be 2.78 feet as against a normal summer slope for this stage of Ontario of 2.07 feet.

"The lessened depth on the Galops weir is due to the loss

of head caused by the river being frozen over and by the iced shallows of the approach. It is extremely gratifying to find that the efficiency of the Galops weir is so little impaired by ice that one per cent. will measure its decreased flowing power, even in February.

"This analysis is extremely satisfactory and the winter flow of the St. Lawrence may be stated with great positiveness. The storage value of the ice period is stated by Mr. Shenehon to be equivalent to about 7 inches on the surface of Lake Ontario."

Extract from the report of Assistant Engineer F. C. Shenehon, for 1902, included in the report of the Chief of Engineers, U. S. Army, for 1902, as follows:

TABLE No. 22a.—SLOPE OF ST. LAWRENCE RIVER FROM OSWEGO TO GALOPS RAPIDS, AND DISCHARGE EFFECT OF ABNORMAL SLOPE IN SPRING AND WINTER MONTHS.

Month.	Water surface Oswego.	Water surface Galops.	Slope.	Normal slope.	Excess slope.	Corresponding loss of discharge.
January	245.43	242.91	2.52	2.07	+0.45	+11,592
February	245.52	242.74	2.78	2.07	.71	18,290
March	245.83	243.23	2.60	2.09	.51	13,138
April	246.39	244.13	2.26	2.12	.14	3,606
May	246.67	244.52	2.15	2.14	+ .01	+ 258
June	246.82	244.70	2.12	2.15	— .03	— 678
July	246.77	244.63	2.14	2.14	.00	000
August	246.43	244.29	2.14	2.13	+ .01	+ 258
September	246.02	243.92	2.10	2.11	.01	— 258
October	245.69	243.57	2.12	2.10	+ .02	+ 516
November	245.44	243.34	2.10	2.09	.01	258
December	245.43	243.28	2.15	2.09	+ .06	+ 1,545
Sums					+1.88	+48,530
Means					+ .157	+ 4,044

"This loss of head in the river above the Galops Rapids, giving less water on the crest of the weir and therefore a lessened discharging power, accounts for about 4,000 cubic feet per second throughout the whole year. Part of this loss of head occurs above Ogdensburg, where a portion of the winter the water is running through a tube, of which the ice forms the upper part, instead of in an open channel, with consequent increased frictional resistance and loss of cross-sectional area, and the remainder in the ice-choked shallows above the Galops.

"Returning to Table 22, in which the discharge is measured, not by the one weir at the Galops, but by the three that have been calibrated, the following losses are shown:

Month.	Loss by Table 22a.	Loss by Table 22.	Subtract.	Loss by Table 22 corrected.
January	11,592	15,800	2,300	13,500
February	18,290	23,950	2,300	21,650
March	13,138	15,380	2,300	13,080
April	3,606	5,495	2,300	3,195
December	1,545	2,437	2,300	137
Sums	48,171	63,062	11,500	51,562
Yearly means	4,014	5,265	.....	4,297

"A comparison of the losses in the first and last columns shows a loss of efficiency of the Galops weir of about 3,300 cubic feet per second for February and about 1,900 for January. The 2,300 subtracted from the values in Table 22, is the August and December indication of the amount by which this method of investigation gives a cumulative error of result.

"Taking the area of Lake Ontario as 7,240 square miles, a discharge of 6,400 cubic feet per second continuing throughout the year represents the volume of water in the top foot of its depth. It follows that the storage value of the ice retardation of flow, 4,000 cubic feet per second throughout the year, is 4,000 divided by 6,400, or 0.625 feet. An open winter, therefore, with other conditions of inflow and rainfall and evaporation remaining normal, would result in a lowering of the surface of the lake about six-tenths of a foot."

Table No. 19—Three Points Section, St. Lawrence River, same report, page 2803, as follows:

TABLE No. 10.—THREE POINTS SECTION, ST. LAWRENCE RIVER.—Station Elements.

Elements. Section Gauge 226.03.	Stations. 1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Depth at station........	4.7	7.2	21.2	23.8	28.4	36.4	42.4	47.6	56.1
2. Width	86	100	100	100	100	100	100	100	100
3. Area.......square feet..	422	801	1,948	2,263	2,703	3,479	4,215	4,880	5,530
4. Approximate index velocity	1.71	3.10	4.33	4.46	4.79	4.93	5.10	5.11	5.26
5. Coefficients:									
Vertical	.888	.908	.885	.856	.877	.895	.907	.948	.941
Transverse	1	1	1	1	1	1	1	1	1
Direction	.956	.951	.970	.988	.993	.996	.996	1	.990
Combined	.849	.863	.858	84.6	.871	.891	.903	.948	.940
6. Direction angle........	17° S.	18° S.	14° S.	9° S.	7° S.	5° S.	5° S.	1° S.	2° N.
7. Percentage discharge...	.3	1.1	3.7	4	5.3	6.9	8.9	10.8	12.4
8. Weight used...........	0	1	4	4	6	7	9	10	12

TABLE No. 10.—THREE POINTS SECTION, ST. LAWRENCE RIVER.—Station Elements.

Elements. Section Gauge 226.03.	Stations. 10.	11.	12.	13.	14.	15.	16.	17.	Weighted means (total)
1. Depth at station........	55.1	52.7	45.3	36.2	26.7	18.3	9.1	5.3	....
2. Width	100	100	100	100	100	100	100	100	1,686
3. Area .....square feet...	5,476	5,242	4,494	3,567	2,656	1,788	986	551	51,091
4. Approximate index velocity	5.20	4.81	4.52	4.22	4.02	4.14	4.07	3.83	4.79
5. Coefficients:									
Vertical	.920	.922	.906	.899	.920	.927	.910	.927	.898
Transverse	1	1	1	1	1	1	1	1	1
Direction	.998	.996	.990	.996	.995	.990	.990	.985	.994
Combined	.918	.918	.896	.895	.916	.918	.918	.914	.908
6. Direction angle.........	4° N.	5° N.	8° N.	5° N.	6° N.	8° N.	8° N.	10° N.	0°. 3 N.
7. Percentage discharge....	11.8	10	8.2	6.1	4.5	3.1	1.8	1	....
8. Weight used	12	10	8	6	5	3	2	1	0

Extract from the report of Assistant Engineer Louis C. Sabin, forming part of the report of the Chief of Engineers, U. S. Army, 1902 (pages 2822-2825), as follows:

"Winter Discharge.—In my annual report of 1900 (Report Chief of Engineers, p. 5398) attention was called to the probable effect of ice upon the discharge of St. Clair River, and the very important effect of this condition upon the levels of Lakes Michigan, Huron, and Erie. In order to test the magnitude of this effect, instructions were received to continue the measurement of discharge through the winter of 1900-1901. It so happened that this winter was a favorable one for the work, as the blocking was more nearly complete and longer continued than during the preceding or following winter.

"The ice that forms on the border of Lake Huron in the early winter finds its way into the river and is finally stopped when the weather becomes cold enough to freeze over some of the more sluggish reaches of the lower river. The ice continues to come in from the lake, the blocking becoming more complete until nearly the entire river is covered. As in some places broken pieces find their way below the surface, partial dams are frequently made. Meantime an ice bridge has formed across the head of the river, which wastes away slowly from the downstream side and is renewed from above.

"It was late in December, 1900, before the effect of ice on the discharge was apparent. During January, 1901, the running ice interfered greatly with the observations, sometimes precluding the possibility of working on the river, but from January 2, to February 2, eleven discharges were measured at section 'Drydock.' Early in February the ice reached and passed this section and eventually covered the river as far up as the mouth of Black River. In anticipation of this, Section 'Craig' had been selected, and gaging stations marked by ranges, and this section was used during February and March, when 38 discharge determinations were made. About March 23, a break occurred, the river cleared to Stag Island, and later to Algonac. It blocked again early in April, and did not finally become entirely clear until May 8. From March 25 to April 26, the conditions varied greatly from day to day, and sixteen measurements were made.

"Plate II shows the changes in the fall from 'G. T. R.' to 'M. B. R.' and from 'M. B. R.' to 'D. D.' during the period December 27, 1900, to May 31, 1901, with notes concerning the ice conditions as nearly as can be stated. On January 16,

the effect of the ice is very marked, the blocking progressing rapidly for several days. About February 2, the ice has extended up the river to section 'Drydock,' and the fall between 'M. B. R.' and 'D. D.' increases to the middle of March, when the ice has reached the mouth of Black River. A temporary break partially cleared this upper reach, and from March 14 to 23, the fall from 'M. B. R.' to 'D. D.' diminished. On March 24 a general break occurred, which restored both the falls to their normal value. Still another blockade in the lower river is shown by the sudden decrease in the fall, beginning April 17, and from this time the blockade was more or less effective until the final clearing of the river on May 8th.

"During February and March, 1901, when section 'Drydock' was blocked with ice, the discharge was measured at section 'Craig.' On this section the meter stations were 100 feet apart, the first one being 50 feet from the dock at west end of section. As the water will show at the east end of the section, it was covered by ice near the east bank, the portion of the section so covered varying from day to day, but never extending west of station 12. The discharge through the partial area represented by station 12, varied from 2,000 to 3,000 cubic foot-seconds. The discharge beyond the twelfth partial area varied from nothing to 1,500 cubic foot-seconds. The velocities were measured by the usual method up to the edge of the ice on the east side, and the discharge beyond was determined by occasional observations through the ice. The discharge beyond station 12 was so small that a considerable percentage of error in its determination would have a trifling effect on the total discharge.

"On this section the observations were so made as to give a vertical curve for each station at every complete observation for discharge. When two meters were used, one was kept at the four-tenths depth point while the other meter occupied successively the odd-numbered tenths of depth, as the one-tenth, the three-tenths, the five-tenths, etc. The following day when the station was visited the one meter remained as before at the four-tenths depth point while the other meter occupied successively the even-numbered tenths of depth.

"The greater number of the discharge measurements on this section, however, were taken with three meters—one remaining at four-tenths depth, while another occupied the surface—the one, two, three, four and five-tenths depth points, successively, and the third meter occupied the bottom, the

nine, eight, seven, six, five and four-tenths depth points, successively. The length of run for each position of the meters was in general 50 seconds, but when the three meters were at four, five and six-tenths depth, respectively, a run of 200 seconds was made. The ratio of the velocity observed at any given point in the vertical to the velocity observed simultaneously at the four-tenths depth point was obtained for each observation, and when combined these gave the coefficient by which it was necessary to multiply the four-tenths depth velocity to give mean velocity for the station. This program gave a complete vertical curve for each observation of discharge, and was equivalent to a direct measurement of the mean velocity. This method was adopted because it was known that enough discharges would not be measured on this section to warrant the refinement of obtaining the vertical curves with the multiple meter set, and the practical agreement of the measurements made at the two sections under similar conditions of slope indicate that the results so obtained are at least as accurate as the effective value of the fall can be obtained.

"Law of Winter Discharge.—In Table No. 5, is given a summary of the discharge measurements taken at section 'Drydock' during the ice period. The elevations of water surface were read from the records of the self-registering gages. The record for 'G. T. R.' was taken twelve minutes early, and of 'M. B. R.' eight minutes early it being considered that this time was required for a given elevation of water surface at the gages to have its effect at the section. In each case the observed elevation is the mean of the elevations corresponding to each observation for current velocity. The quantities in column 9, give the discharge as observed, to the nearest hundred cubic-foot seconds, without any corrections.

"Platting the observed discharges in column 9, with reference to the fall from 'G. T. R.' to 'D. D.' ($=f_2$, col. 7) indicated that the discharge varied approximately as the square root of this fall; but it also appeared that the discharges measured at a high stage were greater than those measured at a low stage. It is evident that the stage is not the controlling factor in the fall under the existing conditions. There are not enough discharges to differentiate the effects of fall and stage with any great accuracy, and the effect of the stage being a comparatively small factor that value of this effect was adopted which when applied to the observed discharge would give values for the discharge at mean stage most nearly

proportional to the square root of the fall. After several trials the following empirical equation was derived for the discharge in cubic feet per second.

"$Q = 205{,}000 \sqrt{f_2} + 12{,}000$ ('G. T. R.' + 579.2) Eq. 2 where f_2 is the fall from 'G. T. R.' to 'D. D.'

"The greatest variation of 'G. T. R.' from the stage 579.2 was 1.1 feet, giving a maximum value to the correction for stage of 13,000 cubic-foot seconds.

"In column 15 of the table this effect of the stage has been applied so that the quantities in this column represent, according to this assumption, the discharge that would have been observed, with the fall that obtained, had the water stage at 'G. T. R.' been 589.2 at the time of the observation. These corrected values of discharge have been platted, and are shown on Plate 3, where the curve $205{,}000 \sqrt{f_2}$ is also drawn.

"In column 16, the discharges, computed by equation 2, for the observed conditions of stage and fall, are given. These values compared with the observed discharges, column 9, give the residuals in column 17. It is seen that eight of these residuals are greater than 6,000 cubic second feet. It is not thought, however, that the observed discharges are in error as much as these residuals indicate, but that the greatest portion of the error is in the determination of the fall between gages. In other words, it is thought that the discharge can be more accurately measured than the actual effective fall. In column 18, equation 2 is used to derive the fall corresponding to the observed values of the discharge, and the residuals are shown in column 19. It is seen that there is but one residual as great as 0.06 foot, or three-quarters of an inch, and all but eight are less than 0.04 foot, or one-half inch. Considering, for example, discharge number 124, the discharge computed from the observed fall differs by 10,200 cubic foot-seconds from the observed discharge; the fall, however, computed from the observed discharge by the same formula differs by only 0.033 foot from the actual fall.

"When the river is covered with ice above the gage at Section 'Drydock' the fall from 'G. T. R.' to 'D. D.' increases with no increase in flow, but rather with a diminished discharge, as the blocking of the river is so much more effective. At such times, therefore, the fall in a reach of the river not obstructed by ice must be used for reference. All of the determinations for discharge taken at section 'Craig' were made under these conditions, and as the range in fall from 'G. T. R.' to 'M. B. R.' during the time these discharges were

taken was too small to develop the law connecting discharge and slope, the discharge at 'Drydock' and 'Craig' have been considered together for this purpose.

"A summary of the 'Craig' discharges is given in Table No. 6. When the discharges measured at both sections were platted with reference to the fall from 'G. T. R.' to 'M. B. R.' the value of discharge appeared to vary more nearly as f_1 0.4 than as f_1 0.5. It was also seen that for a given fall the discharge at high stage was greater than at low, although there was no connection between stage and slope. In this case it was found that if each discharge was corrected to mean stage by applying the factor 10,000 cubic foot seconds per foot change in stage, the results would then more closely follow the fall between the two gages. As before, the greatest correction for stage is 11,000 cubic foot seconds, corresponding to 1.1 feet variation in stage. There is no theoretical reason for this particular value of the stage factor, neither is there any theory advanced for the use of the exponent 0.4 applied to the fall. The equation below agrees more closely with the observed results than any other found, and the use of the exponent 0.5 results in bunching the residuals, although it has been used successfully when the discharges measured at section 'Drydock' are referred to the total fall from 'G. T. R.' to 'D. D.'

"There is one point, however, to which attention should be called in this connection: The area of cross-section of the river at the point where the 'G. T. R.' gage is established is approximately 40,000 square feet, and the cross-sectional area at the location of the 'M. B. R.' gage is approximately 60,000 square feet. (See Table No. 1 and Pl. 1, Report Chief of Engineers, 1900, p. 5363.) The flow is therefore not uniform, and the difference in velocity heads for the two sections is available for overcoming the friction between them. We should then expect the discharge to vary approximately as the square root of the observed fall plus this difference in velocity heads, and this is found to be the case in a general way; but since an equation of this form would not be convenient to use in determining the discharge from an observed fall, it has not been used.

"The equation adopted to connect the discharge and fall is as follows:

$Q = 250{,}000\ f_1\ 0.4 + 10{,}000$ ('G. T. R.'—579.2) Eq. 3 where Q is discharge in cubic foot seconds, and f_1 is the fall in feet from 'G. T. R.' to 'M. B. R.'

"The quantities in column 10 of Tables 5 and 6 represent, according to the assumption that the discharge is increased 10,000 cubic foot seconds for 1 foot rise in stage, what the discharge would have been with the observed fall had 'G. T. R.' been at elevation 579.2. These quantities are platted on the diagram Plate IV, where the curve 250,000 f_1 0.4 is also shown. The quantities in columns 11 are the discharges computed from the equation 3, and these, compared with the observed discharges in columns 9, give the residuals in columns 12.

"Out of 60 measurements on the two sections, 14 have residuals greater than 6,000 cubic foot seconds, but, as in the case of the 'Drydock,' discharges referred to the fall from 'G. T. R.' to 'D. D.,' comparatively small errors in the determination of the fall will account for what appear to be large errors in discharge. The fall computed from the observed discharge for each measurement is shown in columns 13, and the indicated errors in the fall are given in columns 14. Thirteen measurements out of the 60 have residuals greater than 0.02 foot, and the largest error indicate in the fall is less than five-eighths of an inch.

"In a case where the slope is governed by the stage, and the discharge is referred to the latter, suppose one foot rise in stage to be equivalent to 20,000 cubic foot seconds; then an error of 0.05 foot in gage reading is equivalent to 1,000 cubic foot seconds discharge; but suppose a foot rise to stage results in increasing the fall between two gages from 1.0 to 1.1 feet, then if the discharge is considered a linear function of the fall, an error of 0.05 foot in the reading of one gage, resulting in the same error in fall, would be equivalent to 10,000 cubic foot seconds error in discharge. The accuracy demanded in the determination of the water level when the discharge is made a function of the slope is thus apparent, and one should not consider that the water levels are absolute, while all errors are attributed to the determination of the discharge. To illustrate that the falls are really approximate, the ranges in the value of the fall during the time occupied by the discharge measurement are given in Table No. 6 for 5 of the discharges.

"Effect of Ice on Lake Huron Stage.—We may now determine the effect of the ice upon the elevation of Lake Huron during the winters for which we have observations of the local slope. For this determination the discharges that would have taken place had the river remained clear cannot be de-

termined by equation 1, involving the elevation of Lake St. Clair, for during the ice period the diminished supply to Lake St. Clair lowers its level very much and the discharge indicated by equation 1 would be too great. In order to get a quantity with which to compare the actual discharge, the equation derived in 1900, involving only the elevation of Lake Huron, has been used.

"The discharges corresponding to the mean elevations of Lake Huron are shown in column 3 of Table No. 7. The discharges, computed from the known fall at the head of the river are given in column 4; the differences in second feet for each month are shown in column 5, and the effects in feet of depth on Lake Michigan-Huron and Lake Erie are shown in the final columns. It is seen that the effect on Lake Michigan-Huron is 0.31 foot in 1900, 0.52 foot in 1901, and 0.27 foot during the past winter. These quantities will not be affected more than about 0.03 foot by the fact that the quantities in column 3 are derived from the actual lake level instead of from the somewhat lower level that would have obtained for each month after the first had there been no obstruction. The cumulative effect on Lake Erie, however, would be considerably reduced by taking into account the fact that when the lake is lowered by the diminished supply from St. Clair River the discharge of the Niagara River is decreased, partially compensating the loss from above."

Also Table No. 6, Discharge of St. Clair River and Table No. 7, Effect of Ice in St. Clair River, pages 2836-37.

TABLE NO. 6—DISCHARGE OF ST. CLAIR RIVER.

(Measurements at Section Craig during winter of 1900-1901 when river was partially blocked with ice.)

1.	2.	3.	4.	6.	8.	9.	10.	11.	12.	13.	14.
	Observed data. Water levels above mean tide at New York.						Results from equation No. 3				
No. of measurement.	Date. 1901.	G.T.R. Feet.	M.B.R. Feet.	Fall from G.T.R. to M.B.R. Feet.	Meters used at 0.4 depth.	Observed discharge (cubic feet per second).	Q—10,000 (G.T.R.—579.2 (cubic feet per second).	Discharge computed by equation 3 (cubic feet per second).	Residual discharge (computed observed cubic feet per second).	Fall f' computed for observed discharge by equation 3. Feet.	Residual fall (computed observed). Feet.
79	Feb. 4	579.579	579.482	0.098	10B	100,000	96,200	102,500	+ 2,500	0.092	—0.006
80	5	.558	.463	.095	10B	103,800	100,400	100,900	— 2,900	.102	+ .007
81	6	.305	.190	.115	10B	100,500	99,500	106,300	+ 5,800	.100	— .015
82	7	.193	.077	.116	10B	100,800	100,900	105,500	+ 4,700	.103	— .013
83	8	.152	.037	.115	10B	102,100	102,600	104,800	+ 2,700	.108	— .007
84	12	580.002	.916	A.087	10B	111,800	103,800	102,100	— 9,700	.111	+ .024
85	16	579.252	.143	.110	10B	104,300	103,800	103,900	— 400	.111	+ .001
86	19	.505	.398	.108	10B	112,200	109,200	105,700	— 6,500	.126	+ .018
87	20	.700	.612	B.090	10B	115,600	110,600	100,400	—15,200	.130	+ .040
88	21	.348	.240	.108	10B	108,500	107,000	104,100	— 4,400	.120	+ .012
89	23	.163	.058	.105	10B	105,400	105,800	101,100	— 4,300	.116	+ .011
90	25	.145	.037	.108	10B	108,100	108,700	102,100	— 6,000	.124	+ .016
91	26	.255	.142	.113	10B	108,900	108,300	105,100	— 3,800	.124	+ .011
92	27	.292	.178	.113	11B	111,600	110,700	105,400	— 6,200	.130	+ .017
93	28	.066	578.960	.106	11B	105,100	106,400	100,600	— 4,500	.118	+ .012
94	Mar. 1	578.855	.723	.132	11B	106,300	109,700	107,800	+ 1,500	.128	— .004
95	2	579.400	579.300	C.100	11B	111,300	109,300	101,500	— 9,800	.126	+ .028
96	4	.168	.008	D.160	11B	113,900	114,200	119,800	+ 5,900	.141	— .019
97	5	.398	.258	.140	11B	114,700	112,700	115,800	+ 1,100	.137	— .003
98	6	.242	.087	.156	11B	115,600	115,200	119,300	+ 3,700	.144	— .012
99	7	.016	578.869	.147	11B	108,500	110,300	114,300	+ 5,800	.129	— .018
100	8	.100	.938	.162	11B	113,100	114,100	119,700	+ 6,600	.140	— .022
101	9	.419	579.289	E.130	11B	116,100	113,900	112,700	— 3,400	.140	+ .010
102	11	578.695	578.560	.135	11B	107,100	112,100	107,200	+ 100	.134	— .001
103	12	579.482	579.347	.135	11B	119,800	117,000	115,000	— 4,800	.150	+ .015
104	13	.237	.108	.138	11B	115,900	115,500	113,600	— 2,300	.146	+ .006
105	14	.067	578.899	.168	11B	115,800	117,100	121,200	+ 5,400	.150	— .018
106	15	.748	579.610	.138	11B	126,900	121,400	118,700	— 8,200	.165	+ .027
107	16	.292	.161	.131	11B	119,300	118,400	111,800	— 7,500	.154	+ .023
108	18	.381	.205	.176	11B	123,900	122,000	126,600	+ 2,700	.167	— .009
109	19	.192	.034	.158	11B	117,500	117,600	119,400	+ 1,900	.152	— .006
110	22	.349	.177	.172	11B	122,400	120,900	125,100	+ 2,700	.163	— .009
111	23	.301	.108	.192	11B	128,400	127,400	130,200	+ 1,800	.186	— .006

Note.—The range in value of observed fall f'=G.T.R.—M.B.R., is as follows:

A. No. 84, 0.03 to 0.14.
B. No. 87, 0.02 to .12.
C. No. 95, .00 to .13.
D. No. 96, .11 to .23.
E. No. 101, .06 to .16.

TABLE NO. 7.—EFFECT OF ICE IN ST. CLAIR RIVER DURING WINTERS OF 1900, 1901 AND 1902.

1.	2.	3.	4.	5.	6.	7.
				Difference, or effect or ice.		
Date. 1900.	Elevation of Lake Huron at Sand Beach. Feet.	Discharge of St. Clair River by equation 4 of 1900 cubic feet per second.	Discharge derived from fall at head of river by equations Nos. 2 & 3 cu. ft. per second.	Cubic feet per second.	Depth Lake Michigan-Huron. Feet.	Depth Lake Erie. Feet.
January	579.38	183,100	147,300	35,800	0.07	—0.34
February	579.38	183,100	139,200	43,900	.09	— .41
March	579.42	183,900	126,300	57,600	.12	— .54
April	579.53	186,000	173,200	12,800	.03	— .12
Total for winter					.31	
1900.						
December	580.02	195,300	191,100	4,200	.01	— .04
1901.						
January	579.77	190,600	160,300	30,300	.06	— .28
February	579.64	188,100	102,200	85,900	.18	— .81
March	579.62	187,700	133,900	53,800	.11	— .51
April	580.10	196,800	130,500	66,300	.14	— .62
May	580.31	200,800	189,000	11,800	.02	— .11
Total for winter					.52	
1901.						
December	579.60	187,300	174,300	13,000	.03	— .12
1902.						
January	579.51	185,600	124,700	60,900	.13	— .57
February	579.31	181,800	129,100	52,700	.11	— .50
Total for winter					.27	

Extract from the Report of Junior Engineer Murray Blanchard (1903), included in the Report of the Chief of Engineers U. S. Army for 1903 as follows (pages 2813-14):

"Discharge of Detroit River.—The discharge section at Fort Wayne was sounded at the beginning of the season with a 70-pound 'fish' weight suspended on a No. 9 galvanized wire. The heavy weight made the deflection of the sounding wire from the vertical considerably less than in the 1901 soundings. It appears that too large a deflection correction was applied to the soundings in 1901, so that a recomputation of the area for that year has been made by applying the corrections given in Table No. 1, found on page 5330, Appendix III, Report of the Chief of Engineers, United States Army, for 1900. This table, computed by Asst. Engineer F. C.

Shenehon, has been tested on soundings made in the swift current of the Niagara River with various deflections. The close agreement of the two seasons' determinations of the partial areas on Section Fort Wayne indicates that no scour has taken place, and the discrepancy in the total areas has been attributed to errors of observation. The mean of the two determinations of the area has been used in computing all of the discharges summarized in this report, which accounts for the disagreement with the volumes of discharge summarized in the last report. The two area measurements and the mean value used are given in Table No. 1.

"The meters were rated about once a month, and a rate comparison, whenever the meters were used, was made by running them side by side on the section at the same depth. The rating equations of the meters and their application are given in Table No. 2. A comparison of all the ratings made in 1901 and 1902 is shown in Tables Nos. 3 and 4.

"Stations Nos. 4, 9, 15 and 20, were selected for vertical curve observations, and about 20 curves were measured at each station. A comparison with the 1901 multiple meter curves is shown on Plates Nos. 1 to 4. The co-efficients at the 0.3, 0.5 and 0.7 depths are those used in the discharge computations. The mean of the discharges at these depths is used as one discharge, and the means of the three co-efficients for each station agree closely for the two years, except for the shallow station No. 20, where the curve is abnormal and varies. The discrepancy on this station in the two years, although amounting to 2 per cent., would not affect the partial discharge more than 60 cubic feet per second, or 0.0003 of the average total discharge. Therefore the multiple meter co-efficients have been used for both seasons.

"In the two seasons 117 discharges have been measured with a range of 1.6 feet in the Windmill Point or Lake St. Clair stage, of 2.5 feet in the Amherstburg or Lake Erie stage, and of 50,000 cubic feet per second in the discharge. Some of the observations were made when the river was rough and the wind strong, because such conditions are generally found with extreme stages and accompany a very high or low discharge. In such cases, however, there is generally a large fluctuation in the stage of Lake Erie and an uncertainty as to the effective stage of that lake.

"In Table No. 6, the results of the discharge measurements for 1901 and 1902, are given, with the corresponding gage

readings at Windmill Point, Fort Wayne Section, and Amherstburg.

"Very respectfully, your obedient servant,

MURRAY BLANCHARD,
Junior Engineer.

MAJ. W. L. FISK,
Corps of Engineers, U. S. Army."

TABLE 1.—AREA MEASUREMENTS, 1901 AND 1902.

Station.	—Area for Stage 574.4— 1901.	1902.	Mean used.
1	822	773	798
2	3,090	3,024	3,057
3	3,760	3,761	3,760
4	4,021	4,019	4,020
5	4,421	4,435	4,428
6	4,571	4,591	4,581
7	4,582	4,623	4,602
8	4,648	4,640	4,644
9	4,474	4,490	4,482
10	4,285	4,294	4,290
11	4,154	4,182	4,168
12	3,910	3,936	3,923
13	3,862	3,912	3,887
14	4,022	4,068	4,045
15	4,117	4,161	4,139
16	4,107	4,131	4,119
17	4,138	4,190	4,164
18	3,959	3,961	3,960
19	3,624	3,555	3,590
20	1,742	1,717	1,729
21	383	385	384
Total	76,692	76,848	76,770

Extract from the Report of the United States Deep Waterways Commission 1896, being House Document No. 192, 54th Congress 2nd Session; page 28:

"From 1815 to 1830 there appears to have been lower water in all the lakes than the period now passing, except Lake Champlain, which has had the lowest and the highest water of 70 years within the last 30."

Extract from the Report of J. E. Mahoney, included in the report of the U. S. Deep Waterways Commission, page 179, as follows:

"Characteristic High and Low Waters.

"The following table gives the characteristic high and low waters, so far as they can be assigned, from the earliest records down to the present time. These may be accepted provisionally as an indication of the nature of the conclusions from the record.

CHARACTERISTIC HIGH AND LOW WATERS—1815 TO 1895.

HIGH WATERS.

Year.	Lake Michigan (below high water of 1838).		Detroit River (below high water of 1838).		Lake Erie (below high water of 1838).		Lake Ontario (above zero of Oswego gauge).	
1814 and 1815	Unusually high.		Unusually high.				July, 1815	2.89
1838	July	0.00	Summer	0.00	June	0.00	July	4.75
			August	0.49			September	3.77
1853			July	1.07			June	4.25
1858	November	0.69	June	0.15	June 19	—0.25	June	4.75
1859	July	0.65	July	0.65	April	0.27	July	4.78
1862	June	1.67			June	0.69	May	4.76
1870	September	2.12	July	1.29	July	1.35	May	4.83
1876	July	1.20	July	0.57	June	0.50	July	4.25
1886	June	1.16			June	1.20	May	4.52

LOW WATERS.

Year.	Lake Michigan		Detroit River		Lake Erie		Lake Ontario	
					1810 and 1811, general.	6.00	March, 1816	0.06
1819	February	6.67	March	6.67	June	5.33	March	—0.69
	June	4.67	June	5.82	August	5.75	June	1.73
1820	About same as 1819.		About same as 1819.		August	5.04	March	—1.19
1825					General level.	4.00	March	—1.77
1841	December	4.43	October	6.15	October	4.47	December	0.68
1846	December	5.08			March	4.47	March	a 0.00
1847	February	5.50			March	(3.88)	January	1.00
1848	March 6	5.65			March	(4.22)	November	a 0.00
1857	January	3.55	January	3.32	January	3.37	January	0.24
1866	February	4.46			February	3.49	January	1.34
1868	December	4.34	February	3.96	February	4.07	January	0.39
1869	March	4.63	January	3.67	February	3.53	January	1.10
1873	January	4.82	January	3.66	January	3.95	January	0.19
1881	January	3.76	January	3.51	January	3.50	February	0.61
1891	December	4.99			November	3.90	December	0.29
1892	January	4.87			February	4.01	February	0.36
1895	December	5.75			November	4.41	November	—0.71

a—From the original record of Mr. J. W. Judson, C. E., March, 1847 and 1848, for Lake Erie are approximate.

REMARKS:—High Waters: 1790, Lake Erie = 5.50 feet above 1819. The high water of 1838, referred to as a plane of reference, is the plane adopted by the Lake Survey. Low Waters: 1822, Lake Erie, 5 feet below high water of 1838; 1826, Lake Ontario in March = —1.77 feet.

"The Record.

"The record is appended, and is compiled separately for each lake and river, and exhibits all the information obtainable except in regard to the St. Lawrence and Lake Champlain. The list is as follows: Lake Superior, 2 sheets; Lake Michigan-Huron, 4 sheets; Detroit River, 1 sheet; Lake Erie, 5 sheets; Lake Ontario, 5 sheets.

"No diagram has been drawn to exhibit the graphical record, as it has been thought wise to defer this until the final digest has been made. The authority for the information is set forth in connection with the several collections of data.

Very respectfully submitted,

J. E. Maloney."

Extract from the discussion of Defendant's witness Mr. Lyman E. Cooley in the Journal of the Western Society of Engineers for February, 1912, as follows (pages 138-9):

"In 1819 the lakes were the lowest ever known in the history of the Great Lakes—a foot lower than they have ever gone since—at a time when man had made no impression upon the watersheds of the Great Lakes and no improvement of them. In 1838 the lakes went higher than they were ever known to have gone before or since. In fact, the French records at Detroit indicate that the water has not been higher in 200 years. The entire range was about 6¼ feet between those dates. We have had, apparently, changes in the base levels, such as occurred about 1889 in the levels of Lakes Michigan and Huron, by which these lakes were lowered from 6 in. to 1 ft. The cause assigned is probably correct, the changes occurring in the outlet at Port Huron, although there is room for difference of opinion in regard to that, in view of what occurred in 1819 and again in 1838."

The discussion of Mr. George M. Wisner in Journal of the Western Society of Engineers for February, 1912 (p. 126), as follows:

"We need this water, and our right to take it should not be questioned; but it is questioned, and the result will be that, if denied the desired 4,000 cu. ft. of water, the City of Chicago must within the next ten years spend at least $20,000,000 more to take care of its sewage in a less effective manner than it would if this additional flow were available, which, according to the Government's own witnesses, would lower the level of the lake possibly 2¼ inches."

Discussion of Mr. Robert R. McCormick in the Journal of

the Western Society of Engineers, February, 1912 (page 144), as follows:

"The Author.—Our meeting has been successful to this extent, that we have stimulated discussion. From my own point of view, I wish there had been elements here who would have given more spice to it. Perhaps a sense of courtesy towards this meeting prevented me from putting a little accrimony into it myself. Not that I have any feelings of that kind, but what we need is noise, noise to go outside of the four walls of this building, noise which will reach into other states. I do not magnify the facts at all when I say that if all the conditions which Mr. Cooley and I both look forward to had taken place and we went to Congress with a bill, I do not believe it would receive five votes outside of the Illinois delegation. I make that as a statement of opinion—it cannot be made a statement of fact—which has come to me through meeting as many as I have of the residents of other cities on the lake and meeting their firm conviction that the present height or the present lowness of the lake is due to the Chicago Drainage Canal, and that Chicago is finding a cheap way of benefiting itself at the expense of the country. That impression, I wish to say further, has been deliberately fostered."

Extract from the paper by Mr. Clinton B. Stewart, on the Discharge Measurement of the Niagara River at Buffalo, New York, in the Journal of the Western Society of Engineers, read December, 1899. This paper is referred to in Record Volume 6, pages 3521-2. (Page 2 as follows):

"The piers have a battir on the sides of about 1:24, so that the water width of the intermediate spans may be taken as constant. They have a length of about 35 ft. with a cut water on the up-stream end, the down-stream end being rectangular in form. Eddies are produced, by the piers, to some extent, but they do not extend more than about five ft. from the pier, and in most cases the current remains practically linear and with about the same amount of fluctuations as near the middle of the span. It is thought that little error has been introduced from this source."

And again, pages 14 and 15:

"Observations for the mean direction of flow of the river. In order to determine the mean direction of flow of the river, three discharge measurements were selected in which the direction of the current for each of the meter stations had been observed, and when the direction part of the meter had worked very satisfactorily. This gave 3 sets of 21 readings each, and

at distances apart of about 80 ft. The maximum range in direction of the current in any one of the sets was about 10°. The mean of the three sets gave an azimuth of 187°.0 from the magnetic south as the mean direction of flow of the river. The variation of the mean direction at any point from the mean direction of the whole river would not exceed 2° or 3°.

"Observations for the direction of the normal to the bridge or to the line of the discharge section. In these observations the meter was placed on the ground and lined parallel with the cross ties. About 20 observations were made at each end of the bridge. The mean of 40 observations gave the azimuth of the normal to the discharge section as 185° 1′.

"From this it will be seen that the mean direction of flow of the river is 2 degrees to the right from the normal to the discharge section, and that the mean direction of flow and the discharge section are practically at right angles.

"In the case of the individual discharge measurements, no corrections were necessary to the measured velocities on account of the direction of the current. In the case of the transverse curves, the velocities at stations near the piers have been corrected by multiplying them by the cosine of the angle from the mean direction of flow of the river."

Extract from Report on Waterway from Lockport, Illinois, to the mouth of the Illinois River, being House Document No. 1374, 61st Congress 3rd Session (page 9) as follows:

"While it appears to have been assumed that the Sanitary District may be allowed to divert 10,000 second-feet so long as actually necessary for sanitary purposes, the diversion of the waters of the Great Lakes from their natural outlet for power development alone is inadmissible, under the recent treaty between the United States and Great Britain. The future diversion of water from Lake Michigan for any purpose is fraught with difficulties. Not only has Canada an interest in the maintenance of lake levels which the United States must recognize, but every foot of water flowing through the Chicago Drainage Canal lessens the flow at Niagara Falls and at the power sites along the St. Lawrence River, where, due to the fall available, the same amount of water will create about four times the power that can be generated from it on the Des Plaines and Illinois Rivers. The treaty enables riparian owners of Canada, as well as of the United States, who consider themselves injured by such diversion, to bring suit in United States Courts to protect their interests. The claim that more than 1,000 cubic feet per second is required for purposes

of navigation cannot be maintained. The treaty, however, recognizes as proper the use of water for sanitary purposes, and it is the opinion of the Board that only such water should be diverted from Lake Michigan as is indispensable for sanitation, and then only with a provision for proper compensating works in the outlets of the lakes to prevent a lowering of their levels. Water thus diverted may be used incidentally for power purposes, but care must be exercised in authorizing the diversion of water for sanitary purposes, to restrict it to the amount necessary for those purposes alone."

Plot showing analysis of position of meter 2B with 120 pound lead, appended to letter of Mr. Francis C. Shenehon, U. S. Assistant Engineer to Principal Assistant Engineer E. E. Haskell, February 13, 1899, and referred to in the testimony of Defendant's witness Mr. Gardner S. Williams.

Profile of the St. Lawrence River and canals compiled from official records. Signed by Thomas Monro M. Inst. C. E. Commissioner.

Blueprint entitled "Drift of Current Meter B in Niagara River." Gardner S. Williams, consulting engineer, Ann Arbor, Michigan, May 27, 1914, showing an analysis of meter position.

Manuscript copy of Report Board of Engineers to investigate effect of the diversion of water at Chicago, 1895, as follows:

"United States of America
War Department.
Washington, Dec. 1, 1914.

"I hereby certify that the attached papers being a copy of a report dated Aug. 16, 1895, by a Board of Officers constituted by S. O. No. 14, Corps of Engineers, 1895, are true copies of the original on file in the office of the Chief of Engineers, U. S. Army.

(Signed) Dan C. Kingman,
Chief of Engineers, U. S. Army.

"I hereby certify that Dan C. Kingman who signed the foregoing certificate is the Chief of Engineers, U. S. Army, and that to his certification as such full faith and credit are and ought to be given.

"In testimony whereof, I, Lindley M. Garrison, Secretary of War, have hereunto caused the seal of the War Department to be affixed and my name to be subscribed by the Assistant

and Chief Clerk of the said Department, at the City of Washington, this first day of December, 1914.

(Signed) LINDLEY M. GARRISON,
Secretary of War.
By JOHN C. SCOFIELD,
Assistant and Chief Clerk.

(Seal War Department.)

"Chicago, Illinois, August 16, 1895.

Brig. Gen. William P. Craighill,
Chief of Engineers, U. S. A.,
Washington, D. C.

General:

"The Board of Engineers appointed by virtue of S. O. No. 14, C. S. Corps of Engineers to consider and report upon 'the probable effect of the operation of the Chicago Drainage Canal upon the lake and harbor levels and upon the navigation of the Great Lakes and their connecting waterways' submits the following report.

"The Board met in Chicago, August 12, 1895, and on the 13th and 14th accompanied the officers of the Drainage Canal over the line under construction. Every facility and courtesy possible has been extended by the trustees and engineers of the canal for a full investigation of the subject matter. A brief description of the canal is extracted from the printed report furnished the Board by these gentlemen.

"The Main Drainage channel of the Sanitary District of Chicago is now under contract from its confluence with the South Branch of the Chicago River, at Robey Street, in the city of Chicago, to its southern terminus, in Will County, Illinois. At the southern end of the channel the controlling works will be located. Beyond these works, the construction contemplated by the District will be the work necessary for conducting the flow from the channel in conjunction with the waters of the Des Plaines River down the declivity to and through the City of Joliet, and making such changes in the Illinois and Michigan Canal as the new conditions developed will make necessary.

"The first work put under contract extended southwesterly from the Willow Springs road, and these sections were numbered consecutively Nos. 1 to 14. Average length of sections, 1 mile. Easterly from Willow Springs road, the sections are lettered from A to O, omitting J. The lettered sections are, except for a short distance near Summit, entirely in glacial drift, defined in the specifications thus: 'Glacial drift shall comprise the top soil, earth, muck, sand, gravel, clay, hard

pan, boulders, fragmentary rock displaced from its original bed, and any other material that overlies the bed rock.'

"The sections from 1 to 14 were put under contract in July, 1892; from A to F were put under contract late in 1892, and early in 1893; and G to M, inclusive, were contracted for in December, 1893. Sections N and O were put under contract May 2nd, and section 15, August 27th, 1894.

"Earth was first broken on 'Shovel Day', September 3rd, 1892, on the Rock Cut below Lemont.

"The Des Plaines valley is traversed by the river from which it takes its name—a stream of wide fluctuations with no constant and reliable fountain supply. During some seasons its whole discharge would pass through a six-inch pipe, and at others its volume reaches 800,000 cubic feet per minute. Then it rolls majestically along, flooding the whole valley. Such being the situation, control of this stream was a condition precedent to the successful prosecution of the work upon the main Channel. This control has been secured by the outlay of nearly $1,000,000 in constructing what is known as the River Diversion Channel.

"About 13 miles of new river channel had to be excavated with the location of the Main Drainage Channel, and about nineteen miles of levee built to divorce the waters of the Des Plaines watershed from the channel which is to receive the waters of Lake Michigan and pass them on to the Mississippi River, via the lower Des Plaines and the Illinois Rivers. The width of the River Diversion Channel on the bottom is 200 feet, side slopes 1½ to 1, grade generally 12-100 per 1,000 feet.

"At the head of this River Diversion it was necessary to provide a safety valve in the form of a spillway, to allow surplus water to flow towards Chicago, because arrangements have not as yet been perfected for carrying the entire flood waters of the Des Plaines through Joliet.

"This spillway is a concrete dam capped with cut stone, and its wings faced with stone masonry; it is 397 feet long and its crest is 16.25 feet above Chicago datum (this datum is referred to the low water of Lake Michigan of 1847, and is 579.61 above sea level at Sandy Hook). No water flows over this spillway until the volume passing the water gage above it reaches 300,000 cubic feet per minute.

"The cross-section of the earth sections from A to E inclusive is 202 feet on the bottom, side slopes two to one. This section extends for about 500 feet into the west end of F and then reduces to 110 feet on the bottom, preserving the

same side slopes. The explanation for this change of cross-section is as follows: Throughout the rock sections, and those sections in which there is a preponderance of hard material, or where rock may appear, the section adopted is designed according to law for a flow of 600,000 cubic feet of water per minute, which means provision for a population of 3,000,000 people. The narrow channel provides for a flow of 300,000 cubic feet per minute, or for about the present population of Chicago. The enlargement of the narrow channel can be made by the easier method of excavation, such as dredging; whenever the needs of the city require it. The grade throughout the lettered sections is one foot in 40,000 (.025 per 1,000 feet) and the bottom of the channel at Robey Street is 24.448 feet below datum. The numbered sections from No. 1 to No. 6 inclusive are underlaid with solid rock. The width of the bottom in rock, is 160 feet, and walls of masonry laid in cement will be built upon the rock surface to a height of five feet above datum. Section 7 to 14, inclusive, are in solid rock; width at bottom 160 feet, sides vertical, prism taken out in three stopes with offset of six inches on each side for each cut, making top width of 162 feet; grade in rock 1 foot in 20,000 (.05 per 1,000).

"Section No. 15 is also in rock and its cross sections is enlarged at its south end so as to form a 'windage basin' in which large vessels may be turned around. The controlling works are located on this section. These works will consist of gates or movable dams by which the flow of water from the Main Channel into the tail race, which is to deliver the outflow into the Des Plaines River, can be controlled.

"This river below Lockport follows the trough of the valley down a steep declivity to the canal basin in Joliet. The fluctuations in Lake Michigan, by varying slope of water surface, will be felt at the controlling works, and provisions must be made to meet these fluctuations within a range of five feet above datum and eight feet below, or an extreme oscillation of 13 feet. The fall from datum at the controlling works to the level of the upper basin will be about 42 feet, in a distance of about 4 1/3 miles. As the plans for controlling works have not been finally adopted by the Board of Trustees they cannot now be discussed.

"The total amount of excavation involved in the construction of the Main Channel is 26,077,765 cubic yards of glacial drifts and 12,071,668 cubic yards of solid road, or an aggregate of 38,149,433 cubic yards, to which must be added the

material excavated from the River Diversion; glacial drift, 1,564,403 cubic yards; solid rock, 258,926 cubic yards; total River Diversion, 1,823,329; grand total Main Channel and River Diversion, 39,972,762 cubic yards. All of this work is now under contract and in addition thereto 384,958 cubic yards of retaining wall."

In response to the request of the Senior Member of the Board the Board of Trustees of the Sanitary District of Chicago has furnished a report on Lake Level effects on account of the main channel of the Sanitary District of Chicago containing briefs by Trustee L. E. Cooley, C. E., and by Thos. T. Johnston, Assistant Chief Engineer, accompanied by numerous blue prints.

These papers present a full discussion of the subject as viewed by the canal officials, and will be found in the Appendix marked A.

What Is the Outflow of the Lower Lakes?

In November, 1891, the Chief of Engineers U. S. A., at the request of the Secretary of the American Society of Civil Engineers (who had been asked by the Chief Engineer of the Montreal Harbor Commission of Canada, to suggest the subject), ordered a set of observations made to determine the amount of water flowing down the Niagara River. The time was especially propitious as the water was then very low.

The results of these measurements were somewhat unexpected, and they were repeated in May, 1892. The second set corroborated the first, and the whole formed the subject of a report to the Chief of Engineers, which appeared in his annual report of 1893, page 4364, and following. But, as the subject was important, the "Engineering News" anticipated the appearance of the official report by publishing in its issue of March 8, 1893, this report, with the permission of the Chief of Engineers. This publication was the first ever made in which as a result of careful measurements a relation between the level of the lakes, and their outflow, or discharge, had been established and given to the public. Prior determination of this discharge had not attempted to detect this relation, and nothing more than a general determination of a season's work had been published.

In all plans for the Chicago Drainage Canal the early measurements had been taken, and those studying the subject chose such isolated figures as suited them best.

The report of 1892, being so late in appearance, long after

the Drainage Canal was put under construction, escaped the notice of many who are interested in navigation, for two reasons. Some were too busy to see anything, unless specially brought to their notice. Others thought the whole matter already fully canvassed, and settled. It is true there is nothing showing that the consent of Congress had been asked, for this enterprise. Certain that the subject had not been treated as an Interstate affair; to say nothing of its being an International affair. The United States has always been slow to move; with its many sleeping rights it has for many years been loath to exercise them. Not till 1888 did it begin to exercise positive legislation over its navigable waters in order to preserve them for all its citizens. Each River and Harbor bill since then is found to have sections strengthening the hands of those who wish to keep the waterways open, and in good order for all classes of navigators. Not till 1890 had any prohibitive clauses been enacted into laws forbidding, for example, the destruction of channels by improper dumpings. Saw mills went their own unchecked way every year clogging up the streams. Railroads bridged all smaller streams, in the states, without interference from the United States. Many other features can be quoted. But it is sufficient to say that all that is now changed. The adopted policy is to defend, as well as improve all water courses, now navigable, or probably navigable in the reasonably close future. Waterways are under the charge of the United States, and there is no likelihood of their being abandoned for some time to come.

With this an established fact it is impossible to think that U. S. supervision shall not be extended to the Chicago Drainage Canal in due time. Under whatever law built, and for whatever purpose constructed, just so soon as it is shown that that canal affects, or becomes a part of the system of navigable waterways of the United States some supervision or control of it must follow. When boats use it for harbor purposes; when its waters add to the Illinois River, or take from the lakes, they alter natural conditions and the matter rises for consideration under national authority.

The water levels of the Great Lakes are very delicate. Storms, barometric changes, rainfall, even tidal changes are felt. Records show at Buffalo no less than 13 feet as a total possible change, between the lowest and the highest gage readings. Each lake is a basin. The water is constantly pouring in from not only one, but several inlets. The over-

flow, however, is now always out of the one outlet provided for that purpose; the second one formerly at Chicago, has been plugged up.

As in our basins when the water rises enough to take two, three, or more of the small holes to carry it off, it is always to be noted that those holes are always carrying that surplus off. They do not wait until the water has time to pass from one end to the other. In the same channel the head alone governs the rate of outflow, and that head is measured by the gage reading at the outlet. The supply of water in the lake: The net supply, allowing for evaporation, is the sole cause of the outflow. That supply depends solely upon rainfall, but the lake when it receives more than it has been reciving must discharge more. When it has less there is less to run out. If the outlet be dug down, or new ones made the water runs off faster than it ran off before.

The outflow is instantly affected by a changed inflow; Provided there is enough such to increase or reduce the head. If we have a rainfall of one inch over the lake area (and such are not uncommon events), there is a head of one inch to run off. But if there are two outlets to run out of, instead of one this inch must run off sooner than through the one.

If the new outlet should reduce the levels of Lake Michigan and Huron about 6 inches this effect will be produced in full in about two years; it is not then a question of many years as some suppose.

We may feel very sure, therefore, that in this question two points are certain.

1st. The drainage canal is not solely a State affair; but a national one.

2nd. The tapping the lakes must affect their levels. But it is said, first, that the changes in levels does not concern shippers, and then that at most the affects will be trifling.

If one watched carefully the course pursued by shippers one would see that as a rule each vessel carries all that it can take, and get out of its port, or into that it intends to reach. Vessel owners, and managers are very shrewd, watchful men. They know what they can safely carry allowing for storms, and short detentions arising from passing causes. They average pretty well the practicable depths, and carry all the channels will stand. They are as conversant as are theorists about the effects of storms, but they keep good watch on ruling depths. Now should it be certain that these average depths were reduced three inches, or six inches, they must load ac-

cordingly. And not only the large boats, but also the small ones using the small harbors that the large ones cannot go into. All must lose the three, or six inches, as it may be; and not for one, or more trips, but for all trips, and for all time; a diminution of capacity is not a single tax, but a continuous one. A vessel that when light draws six feet, and loaded twelve feet, must lose three inches out of 72, say four per cent. in capacity each loading; a vessel drawing 12 feet light and 20 feet loaded, would lose somewhat over three per cent. in capacity at each end every loading.

Should the loss of levels be six inches instead of three, then these figures become doubled. Will the loss be six inches or will it be three? This is an important question and we have only the Niagara River discharge observations from which to answer it. These cover a range of about 1 foot and eight-tenths. There were scattering observations outside these limits, but the mass of results was secured between gage readings, mean lake level, the highest, and —1. '85. The "smooth curve" as published enables us to note the fall of 0' .53 on the gage per 10,000 cubic feet per second for the first foot of fall and 0' .44 for the whole.

These observations, especially at the lower readings are erratic and indicate a need for more measurements, especially at these levels. This lower portion of the gage should be studied and additional observations made, and the Board is a unit in suggesting the importance of a series of gagings of the St. Clair River at the present time for this purpose, and to furnish additional knowledge of the relation between gage readings, and discharge. The subject is of such general bearing upon the navigation of the lakes, that it demands careful treatment, and full data. The Niagara data do not show how much Lakes Huron and Michigan would be lowered, even if 0'53 were the net loss to Lake Erie. The opinion expressed by Mr. Johnson that the effect on the two upper lakes would be some 15 per cent. greater than upon Erie would seem to point to a probable loss of say 0'61. This possible loss of seven inches certainly is important enough to justify careful measurements of the discharge through the St. Clair. It is true that the law as it stands, and the intention of the Trustees contemplates the abstraction of only 300,000 cubic feet under present conditions, but after the canal is opened measurements would not be so instructive, and we must assume that ultimately the entire 600,000 cubic

feet per minute will be drawn from Lake Michigan as required by the State Law.

The abstraction of 10,000 cubic feet of water per second from Lake Michigan will lower the levels of all the Lakes of the system except Lake Superior and reduce the navigable capacities of all harbors and shallows throughout the system to an extent that may be determined, if at all, by actual measurements only. Under the laws of the United States these changes in capacity cannot be made without Federal authority, and to enable the executive officers of the United States to act advisedly in the matter it is necessary in the opinion of the Board not only that these measurements be taken but that the money cost of restoring the navigable depths in channels and harbors be carefully estimated.

In this connection the Board submits without expression of opinion an estimate prepared by Mr. Charles H. Keep, Secretary of the Lake Carriers Association, of the commercial losses in carrying capacity of the Lake fleet, should a reduction be made in Lake levels of one, three or six inches.

(Appendix Marked B.)

The Board notices that the same peculiarity exhibited by the Niagara discharge curve, is pointed out by Mr. Johnston as existing in the Morris, Ill., and South Branch Chicago River curves. (See page 25 Appendix A1.)

The Board also notes Mr. Johnston's conclusions on page 23, Appendix A-1, that "applying the reasoning to the St. Clair and Detroit Rivers, then the value of Q′—Q may be taken from the diagrams illustrating the tables before described, the only uncertainty being as to the value of "d." Suppose "d" to be unity, and the mean depth 20 feet. Then Q′—Q will equal something greater than 20,000 cubic feet per second," which practically corresponds with the deductions made from the Niagara River observations.

So many uncertainties arise in the application of hydraulic formulae that the only way to ascertain the approximate discharge of these streams is to measure them for periods long enough to eliminate accidental fluctuations and to cover all stages.

While the navigable capacity of all harbors and channels on the Great Lakes below St. Marys Falls will be injuriously affected by a diminution in depth, the navigability of the inner harbor of Chicago will be diminished also by the introduction of a current therein, which in the present condition of the river even with the minimum flow of 5,000 cubic feet per

second or 300,000 cubic feet per minute is entirely inadmissible. The estimates of the effect of the Drainage Canal upon this harbor should also consider this element.

The Board of Trustees have not yet determined upon a plan of treatment of this navigable channel, and their plans may be such as may improve, impair or destroy its utility as a navigable river.

All of which is respectfully submitted.

O. M. Poe,
Col. Corps of Engineers,
Br. Brig. Genl. U. S. Army.
E. H. Ruffner,
Major of Engineers, U. S. A.
W. L. Marshall,
Major Corps of Engineers."

Statistical Report of Lake Commerce passing through Canals at Sault Ste. Marie Michigan and Ontario during season of 1913. This is not to be published in the record, but is placed in the hands of the Commissioner for such reference as either party to this suit may wish to make.

Extract from the letter of Colonel Charles E. L. B. Davis, Corps of Engineers U. S. Army to the Chief of Engineers dated January 12, 1906, and printed in House Document Number 266, 59th Congress, 2nd Session, as follows, pages 5-6:

"Survey of Ship Channel Connecting Waters of the Great Lakes Between Chicago, Duluth and Buffalo.

United States Engineer Office,
"Detroit, Mich., January 12, 1906.

"General: 1. In accordance with instructions contained in Department letter of May 2, 1905, I have the honor to submit the following report and estimates of cost of a—

"Ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, with a view to obtaining depths of twenty-two and twenty-five feet, respectively, and sufficient width.

"2. The present project for a ship channel through the connecting waters of the Great Lakes was adopted by the River and Harbor Act of July 13, 1892, the object being to provide a navigable depth of 20 feet by excavating channels to a minimum width of 300 feet through the shoal places in the specified waters, at an estimated cost of $3,340,000, the scope of improvement being limited to shoals not specifically provided for by the then existing appropriations—that is,

the appropriations made specifically for improving the channels in St. Marys River, St. Clair Flats Canal, and Detroit River.

"3. Under approval of the War Department, dated October 20, 1892, operations were commenced in the spring of 1893, and by 1897 channels of the prescribed depth of 20 feet and widths of 300 feet or more had been excavated through all of the shoal areas originally specified in the project. Since 1898 the work has consisted in increasing the width and depth of channels at angles, some exposed places in the open lake, and other critical points, and in removing many isolated shoals of comparatively small area that have been found to interfere with the safe navigation of the channel by the larger class of vessels now in use.

Planes of Reference.

"4. At the time of the adoption of this project certain planes of reference were adopted for the various portions of the connecting waters referred to mean tide level at New York expressed in feet above that level. For the ten years between 1892 and 1902 the prevailing water levels of Lakes Huron, St. Clair and Erie had been almost continually below the assumed elevations, and in consequence the actual draft available was considerably below the 20 feet called for by the project.

"5. For this reason Maj. W. H. Bixby, Corps of Engineers, then in charge of this District, in his project of October 13, 1902, for the improvement of Middle and West Neebish Channels, recommended certain changes in these reference planes which received the approval of the Secretary of War October 31, 1902, and which have been used in the estimates.

"6. These reference planes are as follows: 601.5 for Lake Superior, 580.2 at the head of Little Rapids, 579.3 through Hay Lake, 578.9 in Little Mud Lake, 578.8 at Sailors Encampment, in Mud Lake, and Lake Huron. Such levels correspondent to 573.8 in Lake St. Clair (head of canal) and 570.8 in Lake Erie, these being the monthly means of November, 1895, when the three lakes taken together were at their lowest since 1860, when the records of Lake Michigan and Huron were commenced."

Extract from the Report of Principal Assistant Engineer Francis C. Shenehon on the hydraulic investigations made in connection with a study for the Preservation of Niagara Falls included in Senate Document No. 105, 62nd Congress, 1st Session. (Chapter 3, including Plates 1 and 3.)

"Chapter 3. The Hydraulic Conditions.

"Lake Erie is a natural basin filled with water; the Niagara River is a notch or cut in its brim permitting definite quantities of water to spill out; and the water flows out here because it is the lowest place on the brim, and because it leads to lower levels, and seaward.

"The notch or sluiceway at the head of the river is in limestone hard enough to resist rapid wear under the influence of the running water. Because the dead water of the lake forms a settling basin, the water at the head of the river carries little sediment, and this accounts for the slight abrasive effect of the flow, and for the stability of this low rock barrier, wier, or dam whose integrity is essential for the retention of Lake Erie at its proper surface level. In discussing the hydraulics of the Niagara River, this low rock barrier, reaching from the head of the river to the International Bridge, will be spoken of as the initial weir.

"The river is flowing almost due north as it breaks out of Lake Erie. (See Pl. 1.) At the head it has the usual trumpet entrance, but narrows down in 1¾ miles to little more than 1,500 feet in width, with a natural depth of about seventeen feet and a velocity as great as 8 miles an hour. As it approaches the International Bridge 1¼ miles farther down, it grows a little wider, deeper, and slower. At the foot of Squaw Island it widens to 2,300 feet, and the first sharp descent of about five feet from the level of the lake is passed. Two miles farther down the river is split into two channels by Grand Island—the Canadian Channel about 10 miles long and the American or Tonawanda Channel about 13 miles long. From Squaw Island to the foot of Grand Island, and as far down as Welland River, the current is moderate and the river is navigable; in fact, the Welland River is a side entrance to the Welland Canal.

"The 'dead line,' marking the beginning of the dangerously swift water approaching the rapids, runs from Chippawa at the mouth of the Welland River across to the entrance of the Hydraulic Canal at Port Day. Along this line velocities run as high at 3½ miles an hour at ordinary stages, and in high water are greater. The uppermost cascades of the rapids approaching the Horseshoe Fall are about a mile below the 'dead line,' and the shallow water marking the brim of the upper river basin is little below Chippawa. From the uppermost cascades to the crest of the Horseshoe Fall is five-eighths of a mile.

"The cataract drops into a deep basin or pool where the current is moderate, with water as deep as 189 feet, and this Upper Gorge pool is navigable from near the cataract to Suspension Bridge, a distance of about 2 miles. At Suspension Bridge is the brim over which the water spills out of the Upper Gorge pool and makes the descent of the Whirlpool Rapids to the Whirlpool. The Whirlpool is another deep basin, the water having a rapid rotary motion. The water is spilled out of the Whirlpool basin over the brim at the head of the Lower Rapids; and at the foot of these rapids, from Lewiston and Queenston down, is the broad, still, deep, navigable river stretching in a straight reach of 7 1/16 miles to Lake Ontario.

"The profile of the river from Chippawa to Lewiston is shown on Plate 2.

"It is evident that the Niagara River is a series of basins or pools, linked by swift water or rapids, which form the sluiceways or spillways from these basins. There are four distinct basins (see Pl. 3) and as these have a most important bearing on the measurement of the river flow, and make the determination of diversion effects possible, the identity of each must be emphasized.

"Lake Erie is the initial or parent pool; from Squaw Island to the rapids above the Cataract is the second, or Grass Island-Chippawa pool; the Upper Gorge is the third pool; and the Whirlpool, the fourth. The peculiarity of these basins is that the height of the water surface near their outlets indicates with considerable precision the amount of water flowing through the river. Because of this fact it is possible, by painting certain graduations on gage boards fixed vertically at the proper elevation and placed in proximity to the crest of each weir, to make the water surface itself disclose the volume of river flow. If such a board were set in Lake Erie at the lighthouse on the north end of the breakwater, and the graduations were in units of a thousand cubic feet per second, each graduation would be a little over half an inch long. The graduations of the board set up in the second pool at Grass Island, or at Chippawa above the Upper Rapids, would have graduations a little more than half as large; at Suspension Bridge, in the third pool, the graduation would be about 1¼ inches long, and in the Whirlpool 1¾ inches.

"An increase in the river flow of 22,400 cubic feet per second at ordinary lake stages, which results from a rise in the water surface of Lake Erie of 1 foot, produces at Chippawa

and Grass Island a rise of 0.56 foot, of 2.29 feet at Suspension Bridge, and 2.47 feet in the Whirlpool.

"These pools are shown in Plate 3. Assumed stages of the several pools are indicated by the scales shown on the left-hand side of each gage board, and the corresponding river flow is shown by the scale on the right-side.

"That the water-surface elevations existing in these several pools should maintain certain definite relations to one another is not accidental, but depends on well-known hydraulic laws. Among hydraulic engineers it is a well known fact that a dam or weir with the water flowing over the crest forms an instrument by which the volume of flow may be measured. After a particular weir has been calibrated the elevation of the water surface, as shown by a water gage in the pool above the crest of the weir, gives the measure of the flow.

"In the case of the Niagara River the weirs are natural formations, and the term 'weir' is not technically precise. Nevertheless, they serve the same purpose as artificial weirs in forming pools by rock rims, or by constrictions. They enable calibrations to be made, so that the water-surface elevation of any pool indicates the corresponding volume of flow.

"The initial weir at the head of the river has a width of 1,690 feet, the width of the second weir at the head of the Cataract Rapids is 3,740 feet, the third at Suspension Bridge at the head of the Whirlpool Rapids 390 feet, and fourth at the head of the Lower Rapids, which is the outlet of the Whirlpool, is 390 feet. Comparing the length of the weir crest at the head of the Upper Rapids with that in the outlet of the Whirlpool, it is not difficult to understand the relative fluctuations of the river. The great length of the weir at the head of the Upper Rapids, 3,740 feet, permits the passage of an increased volume of flow by a small rise; while the short length, 390 feet, of the Whirlpool outlet weir chokes the flow and compels a very considerable rise before the area of outflow is sufficient to pass the additional water. This large movement in the Whirlpool makes the fourth weir an extremely sensitive measuring instrument, and for a similar reason at Suspension Bridge the vertical water movement is large also, and the sensitiveness of the third weir as a measuring instrument is likewise great. The weir at the head of the river has an intermediate length and the rise corresponding to an increment of flow is seen to be intermediate, one foot as against 0.56 foot for the second weir and 2.47 feet for the fourth weir.

The initial weir at the head of the river has a peculiarity not shared by the other three weirs, namely, that it is affected by backwater from the pool below, which reaches from the head of the Upper Rapids to Austin Street, Black Rock, at the foot of Squaw Island. The fall from Lake Erie to Austin Street has already been stated as in the neighborhood of five feet. The very extensive and careful measurements made by the Lake Survey in 1898 to 1900, pointed to the fact that the outflow from Lake Erie was increased about eight-tenths of 1 per cent. by lowering the water surface of the river at Austin Street, one-tenth of a foot, and subsequent investigations at the time of the July-August, 1908, shut down of the Niagara Falls Power Co., as well as certain slope observations, closely corroborate the earlier conclusions.

"While the lower river weirs are entirely free from backwater effect in the pools below them, the initial weir at the head of the river has this greater complexity, and it is because of this fact that the surface level of Lake Erie is affected by the diversion of water in the second pool lying above the first cascades of the Upper Rapids.

"Looking at the other three weirs of the river series from the lower level upward, it is very plain that no known elevation of Lake Ontario, or of the Niagara River at Lewiston, can have any effect whatever in the outflow from the Whirlpool. From Lewiston up to the Whirlpool is a distance of 3⅘ miles, with a rise of 47 feet. In this reach of turbulent rapids and swift water and some cascades, the possibility of backwater due to Lake Ontario's height is unquestionably absent. The height of the water surface in the Whirlpool is therefore dependent on the volume of river flow alone. In the winter season, however, ice in the rapids is not unlikely to create somewhat different conditions of outflow, and for this reason the ice period is not here considered. It is probable that small changes do occur from time to time in the river Reach between the Whirlpool and Lewiston, as well as in the Whirlpool Rapids reach from the Whirlpool to Suspension Bridge. The bottom, however, throughout these reaches is of rock which the current cannot easily move. As regards scour, the condition of the water entering the Whirlpool Rapids is very similar to that of water entering the river from Lake Erie. While the water is violently agitated at the foot of the Cataract, it afterwards passes slowly through the deep settling basin of the upper gorge, where particules detached by the impact of the cataract are precipitated.

"Whatever may be the permanence of the channels of these rapids for a long term of years, the fixity of conditions since water gages were established in the Whirlpool and at Suspension Bridge in 1906, is attested by the water-gage records themselves.

"From the Whirlpool through the Whirlpool Rapids to Suspension Bridge is a river reach of a mile with a rise of 48 feet, and this, like the Lower Rapids is a turbulent series of sluices and rips. That any backwater effect may proceed from normal conditions in the Whirlpool to affect the height of the water at Suspension Bridge and in the Upper Gorge pool is impossible.

"That the height of the water at the foot of the Cataract does not have any backwater effect on the river at the head of the Upper Rapids is manifest.

"The upper river pool terminated by the first uppermost cascades of the Upper Rapids, and of the American Channel, includes the intakes of the Ontario Co. on the Canadian side and of the two large canals on the American side. A nice question in backwater effect may seem to be presented by the locations of the intakes of the Electrical Development Co. and of the Canadian Niagara Falls Power Co. Between the intake of the Ontario Co., and the intake of the Electrical Development Co., is a descent of 23 feet, including four cascades; and from the intake of the Electrical Development Co. to the intake of the Canadian Niagara Falls Power Co. is a descent of 15 feet more, including one cascade. It is very certain that any diversion of water, or any small raising of the water at the last named intake, can have no possible effect on the elevation of the water above the first cascade or in the upper river pool. It is certain also, on the face of it, that any diversion made by the Electrical Development Co., or any small raising of the water at its intake will not effect the upper river above the first cascade. The very presence of the cascades themselves is evidence of water flowing sheer, presenting rather the effect of a free fall than of water passing over a drowned weir."

Also extract from Chapter, "The Outflow of Lake Erie," beginning on page 25 and ending on page 27, as follows:

In the whole length of the Niagara River (except for diversions) practical continuity of flow is in force. That is, the contributions of water entering by creeks or rivers between Buffalo and Youngstown are so trivial, compared to the great volume of river flow that under ordinary summer con-

ditions they may be neglected. Any evaporation from the river surface is also negligible.

It follows that the volume of flow under quiescent or normal conditions is the same for each cross-section of the river. If the volume of flow were measured simultaneously at Buffalo, Suspension Bridge and Lewiston, the results would be the same. The water entering the river at Buffalo passes out of the river at Fort Niagara neither appreciably increased nor diminished.

For this reason it does not make any great difference at what section the volume of flow is measured, except that it is desirable to make the measurements at such a point as will serve to give the most accurate results. A straight reach of river with a smooth bottom, together with a velocity of four or five miles an hour, a depth of 30 feet or more, and a fairly smooth, eddyless surface, presents excellent conditions, and better if the water is running faster below it.

A vertical plane perpendicular to the direction of the current cuts the stream in what is called the hydraulic section. Soundings taken at intervals from bank to bank along the line in which the plane intersects the surface, as every ten feet, develop the bottom profile. The area between the bottom and the water surface is the cross-sectional area. For purposes of current measurement, the river is conceived to be made up of a series of sub-streams flowing side by side, each perhaps 100 feet wide. The vertical line at the middle of each substream is the station, and at some fixed percentage of the depth below the surface on the station, as the four-tenths depth, is the controlling current-measuring point called the index.

The current is running slowly next to the banks and fastest out toward the middle of the river, and the plotted curve showing the velocities (for index depth) at various distances across the section is called the transverse curve of velocities. At different depths the current velocity is different, being swiftest near the surface and perhaps half as swift at the bottom. The plotted curve showing the velocity at a station for each tenth of depth is called the vertical curve of velocities.

Because, at varying distances from the bottom and from the banks, the velocity of water flowing straight and smooth is governed by the laws of fluid friction, no abrupt changes occur, except perhaps very close to the bottom or to the banks. The transition from the high velocity near the surface to the lower velocity a foot above the bottom is gradual,

so that the vertical curve of velocities is generally a smooth curve, and the curves at different stations show great similarity. That the forms of vertical curves in smooth stream flow adhere to type is well recognized, and the vertical curves of the Niagara River are closely approximated by those of the St. Clair and the St. Lawrence Rivers.

The transverse curve of velocities is likewise easy, and reproduces in general outline the bottom profile. The deepest water on the section is also likely to be the swiftest, and as the water grows shallower the velocities grow less. The orderly way in which water flows, with remarkable adherence to a fixed plan, makes the accurate measurement of the volume of flow easily possible.

The preliminary work in measuring the volume of flow consists in accurate soundings and a determination of the cross-sectional area of each substream; then the determination of the velocities at different points in each substream, as percentages of the velocity at the index. The index, which is midway of each substream and at three-tenths or four-tenths depth, is a sampling point for velocities to the extent that the velocity measured there is finally the key to the mean velocity in the whole substream. Before, however, a co-efficient is determined which will reduce the observed velocity at the index to the mean substream velocity, much preliminary work must be done in measuring simultaneously the velocity at the index and at other points in the substream. The possibility of a reduction co-efficient is due to the adherence of the different parts of the substream to fixed relative velocities. Some evidence of this law of stream flow is cited in the report of 1900, already referred to, page 5343. In interpreting this statement of fixed velocity relationships, conditions of river equilibrium are understood, and the measurements at the points must be of long enough duration to eliminate the flame-like spurting and lagging of the current threads characteristic of river flow. In arriving at the co-efficient of reduction, it is necessary also to measure the directions of the current, or its deviation from the normal to the section. The operations having in view the determination of the reduction co-efficients are called co-efficient work.

After the cross-sectional areas and the co-efficients are determined, a single velocity measurement at each of the station indexes constitutes a river traverse or discharge measurement. For each substream the volume of flow is the product of the index velocity multiplied by the reduction co-efficient,

and by the cross-sectional area, at the time of the measurement. The total river volume of flow is the sum of the volumes in all of the substreams.

While a discharge measurement is being made a water gage on the hydraulic section records the water surface elevation, as a basis for determining the cross-sectional areas at the time of the measurements. This is called the section gage. In the measurement of the discharge of the Niagara River at the International Bridge, a second water gage just above the head of the river records the level of Lake Erie. A third gage at Austin Street, Black Rock, records the level there, thus determining the backwater effect of the river below. The velocity measurements in the Niagara River work were made with current meters of the propeller-wheel type, and these were calibrated on still-water bases and subsequently in flowing water. The process of calibration is called rating. For detailed description of meter rating on a still-water base, and for much detail which cannot be repeated here, reference is again invited to the Report of 1900.

The measurements of the volume of flow of the Niagara River were made first at the International Bridge, where the downstream lower bridge chord defined the hydraulic section and the bridge itself served as an observing platform. The river flows in nine streams through the openings of the nine spans. The spans are numbered from east to west, span 9 being next to the Canadian bank. Spans 4, 5 and 6, have clear openings at the water line of about 235 feet, with depths reaching 50.7 feet, and together carry 73.1 per cent of the river flow. The remaining spans vary from 138.4 feet to 187 feet. For purposes of measurement each of the three long openings was conceived to be divided into three substreams, and each of the shorter openings into two substreams, making in all 21 substreams. The index at the stations was taken at three-tenths depth. The International Bridge Section, with the river broken up into nine streams, with the bottom and slopes around the piers somewhat ragged, and the piers themselves creating eddies, proved more complex than a section in the unbroken open river. This complexity made co-efficient work more laborious. The error likely to enter from the added complexity is discussed on page 5332 of the Report of 1900, and appears to be in the neighborhood of a half of 1 per cent.

Chapter VIII.

The Shutdowns of the Niagara Falls Power Co.

On May 13, 1908, the Lake Survey Office was notified by Mr. Philip P. Barton, General Manager of the Niagara Falls Power Co., that, to permit an examination of the east abutment of the upper steel arch bridge, where it was thought to have suffered from the wash of the tunnel discharge, this company would shut down its plant shortly after midnight of June 13.

As the shutdown was to cover a period of some hours, the opportunity to observe the rise of water surface following a return to the river channels of about 8,000 cubic feet per second of flow appeared of great importance. As the rise in the river, provided quiescent weather conditions prevailed, would conversely measure the lowering due to this diversion, elaborate preparations were made to test the rise at critical points, and also to measure the change in diversion causing this rise.

Box gages were set at the heads of each of the two large canals on the American side, to test at intervals the records of the self-registering gages maintained by the power companies. Another gage was set, as in 1907, on the hydraulic section in the Niagara Falls Power Co's canal. A box gage was set also at Prospect Point close to the crest of the American Fall, in the position occupied by the self-registering gage in 1907. To observe precedent conditions, readings at 10-minute intervals were taken on the gage at Prospect Point, beginning on the morning of the 13th, and, to secure a record of conditions during the shutdown and afterwards, were continued day and night up to the morning of the 15th.

To make sure of a record at Buffalo and at the foot of Austin Street, staff-gage readings were taken during the critical period to reinforce the self-registers. The gages at Niagara Falls were insured against stoppages by a constant patrol.

Current-meter measurements of the volume of flow in both large canals were made before the shutdown, as the gates closed, and after they were opened again.

Had the weather conditions remained good, even so brief a period as this would have given some valuable information, for, in addition to the shutdown of the Niagara Falls Power Co., the Niagara Falls Hydraulic Power & Manufacturing Co., had arranged to restrict its flow so as to permit the greatest possible change. Unfortunately, the results were of small value. The shutdown in the power canal began about mid-

night and was completed by 1:20 in the morning. The hydraulic canal, on the other hand, had not completed its partial shutdown before six o'clock Sunday morning. Meanwhile, a stiff southwest storm on Lake Erie arose about midnight and caused the water at Buffalo to rise a foot and a half by three o'clock in the morning. This rise in the lake, causing increased flow in the river and, therefore, greater heights at all points, is entangled with that coming from the shutdown, and the two cannot be separated. The rise on the crest of the American Fall between midnight and three o'clock was 0.1 foot. Up to two o'clock it was 0.06 foot, or three-fourths inch, and this, if attributable solely to shutdown, would be fairly corroborative of anticipated results.

The examinations of the June shutdown having shown the need of repairs on the abutment of the bridge and in the tunnel of the power company, a second shutdown of this company, aggregating practically ten days, was made in July and August. Considerable preparations were again made to make the most of this partial return of the river to a state of nature, and the observations were extended to incorporate very precise information of the influence, not alone on the river-surface levels, but also on Lake Erie's outflow. Early notification was sent to this office by the power company, and the hydraulic company offered its co-operation to the extent of a preliminary increase of flow, and a cessation, on Sunday, July 19, only, of the larger part of the flow of its canal.

The power company shut down at 1:30 on the morning of the 19th, and remained closed until 12:30 on the morning of the 28th, when power house No. 1, resumed, power house No. 2 remaining shut down.

On August 1, at 11:30 at night, the shutdown was again complete and remained so up to 7:30 in the evening of August 2, when both power houses resumed.

The shutdown was, therefore, practically complete on the nine days, July 19 to 27, and nearly complete on August 2, or ten days in all.

The mean condition of the river for these ten days of lessened diversion is compared with the river condition on six days preceding the shutdown, July 13 to 18, and on four days after resumption, August 3 to 6, making ten days in all of the condition of normal diversion.

During the ten days of diversion the mean water consumption of the two American companies was 7,850 cubic feet per second, and during the shutdown it was 1,640 cubic feet, a

change in consumption of 6,210 cubic feet. (See table 39.) The small diversions of these companies prevailing at this time were due to the existing business depression.

The average consumption of the Ontario Co. from July 13 to August 6, as derived from its curves of total load, using a co-efficient of 0.0866 to convert kilowatts to cubic feet per second, was less than 1,500 cubic feet, and was slightly less during the shutdown, owing to the lighter load of the three Sundays included, than in the six days before and four days following. During the shutdown a box gage was established just above the forebay of the Ontario Co. Taken in connection with the Chippewa gage, this gage was an index of the comparative flow over the water wall and through the conduit of this company, in the two periods.

Prior to the shutdown and after resumption the flow in the canals of the American companies was frequently measured with current meters, and during the shutdown of the power company the flow in the hydraulic company's canal was measured daily.

During the 5-day period, July 28 to August 1, while power house No. 2 was still shut down the flow in both canals was measured daily. The flow in the power company's canal was nearly equal to that existing when both power houses were in operation. For this reason the results of this period have small value and do not appear in this report.

During the 25-day period, from July 13 to August 6, self-registering gages were maintained in Lake Erie at Buffalo, and in the river at Black Rock, Schlosser's dock, Grass Island, Wing Dam, and Suspension Bridge; and on the Canadian side at Black Creek, Chippewa, Crest of the Horeshoe Fall, and in the Whirlpool.

During the shutdown, in order to insure observations in case of stoppages of the self-registering gage instruments, readings at 10-minute intervals day and night were made on staff gages in Lake Erie and at Austin Street, Black Rock and the patrol of the self-registers by inspectors was bi-daily or more frequent. No pains were spared to make the record complete and accurate. Additional staff gages were read at Prospect Point, on the crest of the American Fall, and in the canals of the two American Companies, and, as has been before stated, in the approach to the Ontario Company's intake.

During this 25-day period, to corroborate the values of the change in Lake Erie outflow shown by the Suspension Bridge

and Whirlpool gages, 50 measurements of the flow of the river were made at the International Bridge, Buffalo.

The many activities of this period kept a considerable party of civil engineers and assistants busy. In addition, a part of the staff-gage reading at Buffalo and at the Ontario Company's intake was done by an inspector employed by the American section of the International Waterways Commission.

The results of the shutdown are discussed in Chapters IX to XI, entitled "Effect on Lake Erie," "Effect on the Niagara River above the Upper Rapids" and "Effect on Rapids and Falls."

No photographs were made in this period because it was well known in advance that the small change in diversion would have no visible effect on the American Fall, and because increased water consumption by the Canadian Companies to supply the power company's customers with electric current during the shutdown would mask any small effect on the main rapids and Horeshoe Fall.

For this latter reason no gage readings were taken at Terrapin Point, and, except as confirmatory of results elsewhere, little weight has been given to the gage readings on the Canadian end of the Horseshoe Fall.

So far as effects on Lake Erie and the river above the rapids or on the American Fall are concerned, the diversions of the Electrical Development Co. or of the Canadian Niagara Falls Power Co., have no bearing. These two companies combined supplied, according to the total load curves furnished by them, an average of 7,110 kilowatts more during the 10-day period of the shutdown than during the 10-day period of comparison before and after the shutdown; and the production of this excess current meant an additional water consumption not exceeding 1,000 cubic feet per second. The Ontario Co., on the other hand, according to its total load curve, consumed less water by 100 cubic feet during the shutdown than in the period of comparison. This, as has been explained elsewhere, is because the shutdown period contains three Sundays when manufacturing plants were not running, while the period of comparison is all working days.

In discussing the change of flow in the Niagara in these two periods, the small difference in consumption indicated for the Ontario Co. is not considered, because changes in the water wasted over the water wall may exceed this amount and be of different sign.

The detailed results of the shutdown of July-August, 1908, are given in Table 39, and this needs some explanation.

TABLE 39.—THE EFFECTS OF THE SHUTDOWN OF JULY AND AUGUST, 1908.

DURING DIVERSION.

Date 1908.	Mean water diversion (cubic feet per second). Niagara Falls Power Co.	Niagara Falls Hydraulic Power & Manufacturing Co.	Sum.	Elevation of Lake Erie by Buffalo gage. Feet.	River gages (residuals in hundredths of a foot). Austin Street.	Schlosser's Dock.	Grass Island.	Chippawa.	Wing Dam.	Prospect Point.	Residuals of discharge as shown by weirs. Suspension Bridge.	Whirlpool.
July 13	6,300	1,700	8,000	573.26	+ 7	—4	+13	+ 9	+15	...	+ 100	+ 100
July 14	6,500	1,600	8,100	573.28	+11	—7	....	+ 8	+13	...	— 100	+ 700
July 15	6,500	1,500	8,000	573.25	+14	—7	....	+ 8	+12	...	— 100	— 200
July 16	6,300	1,250	7,550	573.13	+12	—7	....	+ 6	....	+5	— 600	+ 300
July 17	6,800	1,200	8,000	573.68	+ 5	—5	+13	+ 5	+12	+5	+1,100	+1,100
July 18	6,700	1,500	8,200	573.51	+11	—2	+14	+13	+14	+5	+ 700	+1,100
Aug. 3	6,000	1,200	7,200	573.12	+11	0	+19	+15	+14	+4	— 200	....
Aug. 4	5,550	1,400	6,950	573.23	+17	+1	+19	+15	+14	+4	+ 100	+1,000
Aug. 5	6,500	1,500	8,000	573.32	+23	+3	+19	+15	....	+4	+ 700	+1,300
Aug. 6	7,000	1,500	8,500	573.40	+11	—2	+13	+10	....	+3	— 400	+ 100
Means (10 days)			7,850	573.318	+12.2	—3.0	+15.7	+10.4	+13.4	+4.3	+ 80	+ 610

TABLE 39.—THE EFFECTS OF THE SHUTDOWN OF JULY AND AUGUST, 1908—Continued.
DURING SHUTDOWN.

Date. 1908.	Mean water diversion (cubic feet per second). Niagara Falls Power Co.	Niagara Falls Hydraulic Power & Manufacturing Co.	Sum.	Elevation of Lake Erie by Buffalo gage. Feet.	River gages (residuals in hundredths of a foot). Austin Street.	Schlosser's Dock.	Grass Island.	Chippawa.	Wing Dam.	Prospect Point.	Residuals of discharge as shown by weirs. Suspension Bridge.	Whirlpool.
July 19.......	....	750	750	573.30	+14	0	+36	+19	+21	+7	−1,800	......
July 20.......	....	1,350	1,350	573.12	+13	+2	+39	+22	+20	+8	− 300	......
July 21.......	....	1,800	1,800	573.15	+12	+6	+40	+23	+20	+8	0	+1,100
July 22.......	....	1,800	1,800	573.25	+14	+3	....	....	+16	+5	− 800	0
July 23.......	....	1,800	1,800	573.05	+15	+4	+38	....	+16	+5	−1,200	+ 100
July 24.......	....	1,750	1,750	752.88	+15	+4	+38	....	+16	+5	−1,000	+ 400
July 25.......	....	1,750	1,750	573.03	+15	+6	+40	+25	+16	+4	− 800	+ 500
July 26.......	....	1,700	1,700	573.01	+19	+7	+42	+25	+15	+4	− 700	+ 700
July 27.......	....	1,600	1,600	573.16	+16	+3	+38	+21	+12	+4	−1,100	− 200
Aug. 2.......	1,000	1,100	2,100	573.10	+17	+3	+35	+20	+10	+5	−1,500	......
Means (10 days)................			1,640	573.105	15.0	+3.8	+38.4	+22.1	+17.1	+5.5	− 920	+ 370

	Decrease in diversion.	Rise at river gauges during shutdown. Austin. Street. Feet.	Schlosser's Dock. Feet.	Grass Island. Feet.	Chippawa. Feet.	Wing Dam. Feet.	Prospect Point. Feet.	Decrease in total river discharge during shutdown. Suspension Bridge. Cubic Feet.	Whirlpool. Cubic Feet.
Summation	6,210	2.8	6.8	22.7	11.7	3.7	1.2	950	240
Mean......cubic feet								600	

River gauges: A (+) residual indicates that the river is higher than its normal height for the corresponding lake stage; A (—) residual indicates that the river is lower than its normal height for the corresponding lake stage.

Residuals of discharge are in cubic feet per second. A (+) residual indicates that the flow in the river is greater than normal for the corresponding height of Lake Erie. A (—) residual indicates that the reverse is true.

Diversions refer to those on American side only. That of the Ontario Power Co. was practically constant for this period.

It will be noticed that Lake Erie at Buffalo was at elevation 573.32 during the ten days of diversion and 573.10 during the shutdown, making the lake 0.22 foot low for the latter period. This difference in level, however, does not produce any error in the results because it is eliminated by reducing to a common lake-level plane. For each day the elevation of the water surface for that day's level of Lake Erie at Buffalo is computed for each gage by its equation of equivalent river heights. If the Chippewa gage on July 14 shows 0.08 foot higher than its computed height, a plus residual (+8) is set down. If on July 20 the river at Chippewa is shown by the gage to be 0.22 foot higher than its computed height, a plus residual (+22) is set down. The excess of the residual during this one day of shutdown over that of this day of diversion (22—8) shows that for exactly the same lake stage the river for the shutdown day is 0.14 foot high, and that is the evidence of these two days as to the effect of the shutdown. The mean residual during the diversion days subtracted algebraically from the mean residual during the shutdown shows, if plus, the rise, and if minus, the lowering due to the shutdown.

The equations of equivalent river height by which these residuals are derived are very exact, but if any small constant error should exist in them it is eliminated by the subtraction.

As, however, any error in the ratio of change at the river gages for a unit change of Lake Erie at Buffalo is not eliminated by subtraction, some discussion is needed to indicate how large it may be.

A gage was maintained at Grass Island in 1903, and the equation resulting from the observation was—

$$\text{Grass Island (1903)} = 560.826 + 0.543\,h \qquad (3)$$

in which h is the water-surface elevation of Lake Erie at Buffalo above 570. The ratio of river change to lake change is 0.543.

In 1907 a gage at the same place showed—

$$\text{Grass Island (1907)} = 560.528 + 0.555\,h \qquad (4)$$

For Lake Erie at stage 573 this gives the water surface at Grass Island as follows:

1903	562.45
1907	562.193

This shows a lowering between 1903 and 1907 of 0.262, or a little over three inches. This lowering is mainly due to the removal of the temporary diverting dam of the Ontario Co., the use of water by that company, and some increased diversions on the American side. The ratios, however, in the two

equations, 1903, 0.543, and 1907, 0.555, differ by but 0.012 foot, or one-eighth inch, for a change of a foot at Buffalo.

A combination of the 1903 and 1907 observations gives a ratio 0.556, or roundly 0.56, which has been used in the reductions and in this report.

As the Chippawa gage is just across the river in the same pool, its equations are of interest in relation to the ratio of change.

The 1906 gage at Chippawa gives—

Chippawa (1906) = 561.240 + 0.549 h (5)

No separate equation is derived for the 1907 observations, but for the observations of 1906 and 1907 combined the following equation results:

Chippawa (1906-7) = 561.228 + 0.557 h (6)

For Lake Erie at 573 these equations give:

Chippawa (1906)	562.887
Chippawa (1906-7)	562.899

The ratio, 0.56, identical with that at Grass Island, has been used in the reductions and in this report.

The four derived ratios summarized are:

Grass Island (1903)	0.543
Grass Island (1907)	.555
Chippawa (1906)	.549
Chippawa (1906-7)	.557

There seems little doubt about the propriety of the ratio 0.56, representing as it does the later conditions. However, if 0.50 were the proper ratio instead of 0.56, the error entering into the results in this pool during the shutdown would not exceed (0.22 × 0.06), or 0.013 foot.

The 1906 observations gave for the Willow Island gage at the head of the American Channel a ratio of 0.422, and the 1907 observations for Wing Dam a little further downstream give 0.412.

In the Whirlpool the following variations of ratio are shown:

1906	2.478
1907	2.482
1906-7	2.458

and the ratio used in reductions is 2.47.

For Suspension Bridge the range of ratios is greater:

1906	2.285
1907	2.375
1906-7	2.286

and 2.29 was accepted as a proper ratio.

At Austin Street, Black Rock, the observations show ratios as follows:

1903	0.830
1907	.802
1899, 1900, 1903, 1907	.821

and 0.82 is accepted as correct.

The ratios at Prospect Point, Terrapin Point and at the Canadian end of the Horseshoe Fall are likely to have errors as great as five per cent. or more of their values, because the ratios depend on the records of a few months only.

TABLE 40. COMPARISON OF DAILY MEAN WATER-SURFACE ELEVATIONS OBSERVED AND COMPUTED

Date 1908	Buffalo Feet	Austin Street Observed Feet	Austin Street Computed Feet	River high	Schlossers Dock Observed Feet	Schlossers Dock Computed Feet	River high	Chippawa Observed Feet	Chippawa Computed Feet	River high
July 13	573.26	567.98	567.91	+ 7	564.16	564.20	— 4	563.12	563.03	+ 9
July 14	573.28	568.03	567.92	+11	564.15	564.22	— 7	563.12	563.04	+ 8
July 15	573.25	568.04	567.9[illegible]	+14	564.16	564.23	— 7	563.14	563.06	+ 8
July 16	573.13	567.92	567.80	+12	564.09	564.16	— 7	563.05	562.99	+ 6
July 17	573.68	568.30	568.25	+ 5	564.36	564.41	— 5	563.28	563.23	+ 5
July 18	573.51	568.22	568.11	+11	564.35	564.37	— 2	563.32	563.19	+13
July 19[1]	573.30	568.08	567.94	+14	564.27	564.27	+ 0	563.28	563.09	+19
July 20[1]	573.12	567.92	567.79	+13	564.16	564.14	+ 2	563.19	562.97	+22
July 21[1]	573.15	567.94	567.82	+12	564.17	564.11	+ 6	563.18	562.95	+23
July 22[1]	573.25	568.04	567.90	+14	564.25	564.22	+ 3	.....	563.05	....
July 23[1]	573.05	567.89	567.74	+15	564.15	564.11	+ 4	.....	562.94	....
July 24[1]	572.88	567.75	567.60	+15	564.04	564.00	+ 4	.....	562.84	....
July 25[1]	573.03	567.87	567.72	+15	564.11	564.05	+ 6	563.14	562.89	+25
July 26[1]	573.01	567.89	567.70	+19	564.14	564.07	+ 7	563.16	562.91	+25
July 27[1]	573.16	567.98	567.82	+16	564.19	564.16	+ 3	563.20	562.99	+21
July 28[2]	573.16	567.97	567.82	+15	564.17	564.15	+ 2	563.15	562.98	+17
July 29[2]	573.11	567.95	567.78	+17	564.13	564.14	— 1	563.11	562.97	+14
July 30[2]	573.16	567.97	567.82	+15	564.14	564.15	— 1	563.12	562.98	+14
July 31[2]	573.17	567.98	567.83	+15	564.13	564.17	— 4	563.12	563.00	+12
Aug. 1[1]	572.94	567.76	567.64	+12	563.99	564.01	— 2	562.98	562.85	+13
Aug. 2[1]	573.10	567.95	567.78	+17	564.17	564.14	+ 3	563.18	562.98	+20
Aug. 3	573.12	567.90	567.79	+11	564.10	564.10	+ 0	563.08	562.93	+15
Aug. 4	573.23	568.02	567.85	+17	564.18	564.17	+ 1	563.15	563.00	+15
Aug. 5	573.32	568.19	567.96	+23	564.32	564.29	+ 3	563.26	563.11	+15
Aug. 6	573.40	568.13	568.02	+11	564.23	564.25	+ 2	563.18	563.08	+10

Date 1908	Buffalo Feet	Grass Island Observed Feet	Grass Island Computed Feet	River high	Wing Dam Observed Feet	Wing Dam Computed Feet	River high	Prospect Point Observed Feet	Prospect Point Computed Feet	River high
July 13	573.36	562.46	562.33	+13	558.47	558.32	+15	.....	512.83	....
July 14	573.28	.....	562.34	....	558.46	558.32	+13	.....	512.89	....
July 15	573.25	.....	562.35	....	558.46	558.34	+13	.....	512.89	....
July 16	573.13	.....	562.29	....	.....	558.29	....	512.93	512.88	+ 5
July 17	573.68	562.65	562.53	+13	558.59	558.47	+13	512.98	512.95	+ 6
July 18	573.51	562.62	562.48	+14	558.58	559.44	+14	512.97	512.92	+ 5
July 19[1]	573.30	562.75	562.39	+36	558.58	558.37	+21	512.97	512.90	+ 7
July 20[1]	573.12	562.65	562.36	+39	558.48	558.28	+20	512.95	512.87	+ 8
July 21[2]	573.15	562.64	562.34	+40	558.46	558.26	+20	512.94	512.86	+ 8
July 22[2]	573.35	.....	562.34	....	558.50	558.34	+16	512.94	512.89	+ 5
July 23[1]	573.05	562.62	562.24	+38	558.42	558.26	+16	512.91	512.86	+ 5
July 24[2]	572.88	562.52	562.14	+38	558.34	558.18	+16	512.89	512.84	+ 5
July 25[1]	573.03	562.59	562.19	+40	558.38	558.22	+16	512.89	512.85	+ 4
July 26[1]	573.01	562.62	562.20	+42	558.38	558.23	+15	512.90	512.86	+ 4
July 27[2]	573.16	562.66	562.28	+38	558.41	558.29	+12	512.91	512.87	+ 4
July 28[2]	573.16	562.49	562.28	+21	558.37	558.29	+08	512.90	512.87	+ 3
July 29[2]	573.11	562.46	562.26	+20	558.37	558.28	+09	512.90	512.87	+ 3
July 30[2]	573.16	562.45	562.28	+17	558.39	558.29	+10	512.91	512.87	+ 4
July 31[2]	573.17	562.44	562.30	+14	558.40	558.30	+10	512.91	512.88	+ 3
Aug. 1[2]	572.94	562.31	562.14	+18	558.31	558.19	+12	512.88	512.84	+ 4
Aug. 2[2]	573.10	562.62	562.27	+35	558.47	558.28	+19	512.92	512.87	+ 5
Aug. 3	573.12	562.42	562.28	+19	558.39	558.25	+14	512.90	512.86	+ 4
Aug. 4	573.22	562.48	562.29	+19	558.44	558.30	+14	512.92	512.88	+ 4
Aug. 5	573.22	562.59	562.40	+19	.....	558.38	....	512.94	512.90	+ 4
Aug. 6	573.40	562.50	562.37	+13	.....	558.36	....	512.92	512.89	+ 3

[1]Shutdown. [2]Partial Shutdown.

The residuals of Tables 39 and 40, therefore, in the conversion processes necessary to make the results comparable, have not been subjected to distortion.

The mean decrease in the diversion in the two 10-day periods compared was 6,210 cubic feet per second. The first effect of this was to add that much water to the flow over the Rapids, and this required a rise in the Chippawa-Grass Island pool of 0.117 foot as shown at Chippawa; this backed up the river so as to cause a rise at Austin street, Black Rock, of 0.028; and this in turn lessened the outflow from Lake Erie, as indicated by the gages at Suspension Bridge and in the Whirlpool by 600 cubic feet per second. The final outcome was that the change in flow over the Rapids was 6,210 less 600, or roundly 5,600, and the bulk of this went over the main rapids. At the same time, the Electrical Development Co. and the Canadian Niagara Falls Co. assuming part of the burden laid down by the Niagara Falls Power Co. which had shut down, took from the main rapids perhaps 1,000 cubic feet, giving a probable excess flow over these rapids and the Horeshoe Fall of only 4,500 cubic feet per second.

In order, therefore, to derive the final effect of a diversion of 10,000 cubic feet in the American Canals, the difference in the residuals shown in the summary must be multiplied by 10,000/5600,, or by 1.79. The effects of 10,000 cubic feet so diverted are given in the discussion in specific chapters.

The agreement of the residuals from day to day is sufficient warrant that heavy rainfalls or wind storms did not interfere with the essential fairness of the test; but to make the evidence complete, the following abstracts furnished by the weather observer at Buffalo, Mr. D. Cuthbertson, are included in this report:

TABLE 41.—WEATHER CONDITIONS, 1908.

	Wind: Direction from which blows.	Wind: Velocity (miles per hour).	Precipitation (inches).	Barometer.
During Diversion.				
July 13, partly cloudy..........	SW.	9.0	0.41	29.18
July 14, partly cloudy..........	SW.	11.0	.00	29.09
July 15, partly cloudy..........	NW.	16.0	.00	29.20
July 16, clear..................	SW.	8.0	.00	29.22
July 17, cloudy.................	S. & SW.	20.0	1.02	28.94
July 18, cloudy.................	W. & SW.	16.0	.92	28.96
Aug. 3, partly cloudy..........	SW.	10.0	.00	29.18
Aug. 4, partly cloudy..........	SW.	17.0	Trace	29.06
Aug. 5, cloudy..................	SW.	18.0	.10	28.94
Aug. 6, partly cloudy..........	SW.	17.0	.01	29.02
Total			2.55	
Mean	SW.	14.2	....	29.07
During Shutdown.				
July 19, cloudy.................	NE.	7.0	0.05	29.18
July 20, partly cloudy..........	N.	7.0	0.00	29.22
July 21, cloudy.................	N.	5.0	.77	29.20
July 22, clear..................	SW.	9.0	Trace	29.28
July 23, clear..................	NE.	8.0	.00	29.36
July 24, cloudy.................	E.	14.0	.04	29.40
July 25, partly cloudy..........	E.	9.0	.07	29.39
July 26, clear..................	E.	9.0	.00	29.36
July 27, clear..................	NE.	8.0	.00	29.28
Aug. 2, clear..................	N.	9.0	.01	29.18
Total	....	....	.94	.....
Mean	N. & E.	8.5	....	29.29
Differences		5.7	1.61	—0.22

The fact that Lake Erie, with its 240 miles of length, was but 0.22 foot higher during the 10-day period of diversion than during the shutdown indicates the small effect of the southwest wind, with its higher velocity, as opposed to the north and east winds of the shutdown period.

The precipitation, except as it might cause a slight rise in Chippawa Creek, is of little moment. The high precipitation of July 17 and 18, during diversion, was probably still running off on the 19th and 20th, and therefore affected both periods, and its influence is largely eliminated by subtraction.

Note:—In Appendix 3, the following tabulations of data are given:

Table 42—Volume of river flow by three weirs.

Table 43—Variation at different gages.

Table 44—Flow in power canal for shutdown periods.

Table 45—Flow in hydraulic canal for shutdown periods.

Table 46—Water-surface elevations at various gages during shutdown period."

Extract from the same document (page 50) as follows:

"At the time of the shutdown of the Niagara Falls Power Co. in July-August, 1908, the change in the flow over the Rapids was the amount due to the return to the river of the diversion of 6,210 cubic feet per second, less 600 cubic second-feet decrease in Lake Erie outflow, or 5,610 in all. As at that time the normal river flow was upwards of 224,000 cubic second feet, the change in the river flow was only 2½ per cent. While this is not a large quantity to predict results upon, it is a full third of existing local diversions. (See Table 39, Chapter VIII.)

"The lowering at Chippawa due to this diversion was proved by the shutdown to be at the rate of 0.21 foot for a diversion of 10,000 feet, or 0.04 foot (½ inch) less than computed from the observed equivalent river heights. At Grass Island it was 0.40, or 0.15 foot more than shown by equivalent river heights, but an excess was expected here as a localized effect."

Extract from the same document as follows (page 59):

"To verify the cross-sectional area derived by the methods described above, Section No. 1 was sounded with a 95-pound projectile-shaped cast-iron weight. The area resulting from these soundings showed for identical gage heights about ½ of 1 per cent. larger than by the more precise method of level and rod."

Extract from same document Chapter 15, current meter tests (pages 72 to 74, inclusive), as follows:

"Chapter XV. Current-Meter Tests.

"The hydraulic work of the Lake Survey on the outflow of the Great Lakes depends fundamentally for its accuracy on the proposition that the Haskell Current Meter rated on a still-water base gives the true velocity of flowing water. The work of the Lake Survey up to the time of the experiments here briefly described contains no demonstration on this vital points.

"On the face of it, an efficient rating on a still-water base, in which a mass of water is at rest and the instrument is passed through it, should show the same wheel revolutions as a current rating, in which the meter is at rest and the water flows through it. It would seem to be merely a matter of relative motion between instrument and water. However, it is claimed that the impact on the wheel vanes of the particles of flowing water, owing to the intricate nature of their movements, does not have the same effect in wheel revolutions

as the impact between the vanes and the inert particles of still water.

"In submitting formulas for discharge of the Niagara and St. Lawrence Rivers, it seemed proper to apply a correction for instrumental error, if such error existed, and these experiments were made to determine this point.

"The Haskell Current Meters, one of type A, called L. S. 4A, and one of type B, L. S. 1B, were carefully rated on a still-water base. The methods used were similar to those used in rating meters for the discharge work in the Niagara and St. Lawrence Rivers, and described in the Reports of the Chief of Engineers, United States Army, for 1900 and 1901, except that the meter was suspended from the deck of a light catamaran, whose hulls were of 8-inch diameter cedar poles, with a clear width of 12 feet between hulls.

"Each meter was rated three times, and the rating equation is derived from all observations corresponding to the river velocities of the current rating.

"In the still-water rating, a 200-foot base was used, marked by beads soldered on a galvanized-iron wire. This wire was stretched taut over the still water, and acted in addition as a guide for the catamaran.

"The current rating of the meters was done in the Detroit River just above the Lake Survey depot at Fort Wayne, and about 200 feet out from the dock line.

"A section of the steel pontoon sweep was suspended in the current, held by a head anchor. A second section was suspended tandem from the first by two galvanized-iron wires, one on each side, having beads soldered on them 200 feet apart. The starboard wire formed the current rating base. The length between beads of the wires was measured, before and after the tests, by a steel tape.

"The sweep catamarans have decks that overhang at the sides the cylindrical steel hulls. These overhangs were extended so as to drop the meters into the water 12 feet outside the starboard hulls, in order to place the instruments where the current lines would be entirely clear of hull influences.

"The 4A meter, was placed abreast the zero bead on the upper catamaran; the 1B meter was about five feet downstream from the 200-foot bead on the lower catamaran. The axes of the meter wheels were set 1 foot below the water surface.

"The two catamarans hanging fair with the current

aligned the meters so that the current threads passing the first passed close to the second also. The catamarans showed little movement, either sidewise or streamwise.

"As doubt exists as to whether a float travels at the same speed as the water in which it is immersed, and as a float must penerate the surface skin and be in some measure affected by the wind, it seemed best to avoid floats, and to make visible a ball of the water itself, so that its transit between the two terminal beads could be timed. It was found that about four ounces of a strong fluid, bluing, or a strong solution of aniline red, injected into the river at a depth of about a foot, would color a ball of water perhaps a foot in diameter at the start, which held together so that about 70 seconds later it would complete the transit of the 200-foot base, with a size not often more than double, and still a fairly compact mass of color.

"The colored water was injected about five feet upstream and a little to one side of the upper meter, 4A, using a small bicycle pump, pointed downwards and moving at the speed of the water as closely as it could be followed. When the center of the ball of color passed the initial bead of the base wire, the registration of both meters was started by pressing the stems of two stop watches. When its center reached the 200-foot bead, its transit was signaled and both registers were thrown out of circuit by stopping the stop watches. The total number of wheel revolutions for each observation, the transit time of the fluid, and its path were noted.

TABLE 66.—TESTS OF ACCURACY OF HASKELL CURRENT METERS L. S. 4A AND L. S. 1B IN DETROIT RIVER.

Number of observation. a	Date. b	Time of day. c	Velocity (feet per second). By meter 4A. d	By meter 1B. e	Mean by meters. f	By fluid transit. g	Residuals. f-g
	1906.	P. M.					
1	June 1	1.00	2.89	2.97	2.93	2.99	— 6
2	do	1.06	2.89	2.84	2.86	2.96	—10
3	do	1.10	2.83	2.72	2.78	2.74	+ 4
4	do	1.12	2.87	2.74	2.80	2.88	— 8
5	do	1.15	2.81	2.86	2.84	2.92	— 8
6	do	1.17	2.81	2.86	2.84	2.88	— 4
7	do	1.20	2.75	2.68	2.72	2.83	—11
8	do	1.22	2.83	2.84	2.84	2.86	— 2
9	do	1.27	2.81	2.76	2.78	2.87	— 9
10	do	1.30	2.82	2.72	2.77	2.81	— 4
11	do	1.35	2.81	2.90	2.86	2.88	— 2
12	do	1.37	2.58	2.72	2.65	2.78	—13
13	do	1.40	2.62	2.70	2.66	2.66	0
14	do	1.48	2.84	2.96	2.90	2.79	+11
15	do	1.53	2.86	3.02	2.94	2.97	— 3
16	do	1.55	2.86	2.91	2.88	2.92	— 4
17	do	1.57	2.86	2.87	2.86	2.84	+ 2
18	do	1.59	2.86	2.82	2.84	2.87	— 3
19	do	2.00	2.72	2.85	2.78	2.72	— 6
20	do	2.02	2.79	2.70	2.74	2.80	— 6
21	do	3.32	2.72	2.76	2.74	2.72	+ 2
22	do	3.35	2.81	2.85	2.83	2.70	+13
23	do	3.37	2.88	2.86	2.87	2.84	+ 3
24	do	3.38	2.89	2.89	2.89	2.92	— 3
25	do	3.41	2.86	2.92	2.89	2.96	— 7
26	do	3.43	2.82	2.80	2.81	2.84	— 3
27	do	3.45	2.76	2.89	2.82	2.88	— 6
28	do	3.47	2.87	2.84	2.86	2.85	+ 1
29	do	3.50	2.83	2.85	2.84	2.92	— 8
30	do	3.52	2.83	2.96	2.90	2.94	— 4
31	do	3.56	2.74	2.85	2.80	2.80	0
32	do	4.01	2.82	2.90	2.86	2.87	— 1
33	do	4.03	2.82	2.85	2.84	2.82	+ 2
34	do	4.05	2.86	2.87	2.86	2.80	+ 6
35	do	4.07	2.86	2.87	2.86	2.80	+ 6
36	do	4.09	2.80	2.91	2.86	2.70	+16
37	do	4.11	2.74	2.90	2.82	2.70	+12
38	do	4.13	2.65	2.68	2.66	2.68	— 2
39	do	4.15	2.71	2.73	2.72	2.78	— 6
40	do	4.17	2.65	2.67	2.66	2.80	—14
41	do	4.19	2.65	2.65	2.65	2.53	+12
42	do	4.22	2.68	2.72	2.70	2.70	0
43	do	4.25	2.74	2.71	2.72	2.80	— 8
44	do	4.27	2.70	2.74	2.72	2.67	+ 5
		A. M.					
45	June 2	10.45	2.90	2.96	2.93	2.82	+11
46	do	10.48	3.04	2.99	3.02	2.92	+10
47	do	10.50	2.99	3.04	3.02	3.04	— 2
48	do	10.52	2.83	3.01	2.92	2.85	+ 7
49	do	10.55	2.92	2.98	2.95	2.93	+ 2
50	do	11.00	2.88	2.90	2.89	2.88	+ 1
51	do	11.03	3.01	2.93	2.96	3.01	— 5
52	do	11.07	2.93	3.01	2.97	2.92	+ 5

53	do	11.10	2.98	2.98	2.98	2.85	+13
54	do	11.14	2.95	2.96	2.96	2.90	+ 6
55	do	11.15	2.90	2.98	2.94	2.96	− 2
56	do	11.20	2.97	2.98	2.98	2.96	+ 2
57	do	11.22	2.88	3.03	2.96	3.11	−15
58	do	11.26	2.93	3.01	2.97	2.92	+ 5
		P. M.					
59	do	12.57	3.00	2.99	3.00	3.01	− 1
60	do	12.59	3.01	3.07	3.04	3.03	+ 1
61	do	1.00	2.97	2.97	2.97	2.89	+ 8
62	do	1.39	2.88	2.91	2.90	2.85	+ 5
63	do	1.41	2.88	2.94	2.91	2.93	− 2
64	do	1.44	2.85	2.92	2.88	2.92	− 4
65	do	1.45	2.95	2.96	2.96	2.85	+11
66	do	1.47	2.87	2.92	2.90	2.90	0
67	do	1.48	2.85	2.86	2.86	2.85	+ 1
68	do	1.50	2.95	2.94	2.94	2.99	− 5
69	do	1.52	2.91	2.91	2.91	2.86	+ 5
70	do	1.55	2.88	2.94	2.91	2.91	0
71	do	1.57	2.88	2.89	2.88	2.92	− 4
72	do	1.59	2.89	2.87	2.88	2.96	− 8
73	do	2.00	2.89	2.94	2.92	2.91	+ 1
74	do	2.02	2.84	2.89	2.86	2.82	+ 4
75	do	2.06	2.75	2.89	2.82	2.80	+ 2
76	do	2.07	2.93	2.84	2.88	3.05	−17
Means			2.843	2.873	2.859	2.862	5.5

Still water base and current base 200 feet long. Current flows S. W.
June 1—Weather fair. Wind 4 to 6 miles per hour from W.
June 2—Weather fair. Wind 10 to 12 miles per hour from N. N. W.

"The 76 observations of Table 66 show the result in detail. The velocity of the current as shown by the color fluid is taken as the true velocity and is given in column g. The velocity of the current as shown by the meters is given in columns d and e and the mean velocities shown by the two meters in column f. The mean velocity shown by the fluid and by the mean of the two meters for the 76 observations is practically identical—2.862 and 2.859 feet per second.

"On June 1, 44 observations showed a mean velocity of 2.818 feet per second by the fluid and 2.806 by the meters, the meters giving a lower velocity by nearly ¼ of 1 per cent. On June 2, 32 observations showed a mean velocity of 2.922 by fluid and by the meters 2.933, the meters giving a higher velocity by about ⅓ of 1 per cent. These small divergencies are the expected errors of observations characteristic of hydraulic work. Individual observations show larger divergencies, coming from fluctuating velocities.

"The tests demonstrate conclusively the correctness of the indications of the Haskell meters.

"The 4A meter rated in these experiments was the meter most largely used in the measurements of the Niagara and St. Lawrence Rivers, and the 1B meter was used in the lat-

ter river. Both of these meters were used in the measurements of the flow in the Niagara Falls Power Co.'s canal (see Chapter XII) and with velocities close to those of the tests of 1906.

"The correction for instrumental error is taken as zero."

Letter from Major Charles S. Bromwell, U. S. Engineer's Office, Chicago, to Thomas A. Smyth, President Sanitary District, dated February 24, 1913, as follows:

"Engineer Office, United States Army.
509 Federal Building.
Chicago, Illinois, Feb. 24, 1913.

Mr. Thomas A. Smyth,
President, Sanitary District of Chicago,
American Trust Building,
Chicago, Ill.

Dear Sir:

"I am directed by the War Department to notify you that measurements made by the Engineer Department during January indicate that since the Secretary of War's decision of January 8, 1913, you have been diverting from Lake Michigan more water than the 4,167 second feet authorized by the existing War Department permits.

"Your attention is invited to Section 10 of the Act of March 3, 1899, which is being violated by such diversion, also to the provisions of Sections 12 and 17 of the same act, a marked copy of which is inclosed.

"Kindly advise this office what steps, if any, you propose to take to keep future diversions within the limits of the existing War Department permits and how soon such reduction of diversion may be expected.

"I have also to inform you that a continuation of the excess diversion may require action by the United States District Attorney.

Very respectfully,
C. H. B.,
Major, Corps of Engineers.

S
1 inclosure
CHI.R
140/233."

Letter from Thomas A. Smyth, President Sanitary District to Major Charles S. Bromwell, dated February 27, 1913, as follows:

"Letterhead of
The Sanitary District of Chicago
American Trust Building.
February 27, 1913.

Major Charles S. Bromwell,
Corps of Engineers, U. S. A.
Federal Building, Chicago, Ill.

Dear Sir:

"I am in receipt of your favor of the 24th instant, concerning the diversion of water from Lake Michigan through the Channel of the Sanitary District.

"As a number of the members of the Board will be out of town during the next two weeks, I have called a meeting of the Board for the 13th prox., at which time your letter will be placed before them for consideration and prompt reply.

Yours very truly,
(Signed) THOMAS A. SMYTH,
President.

A true copy."

Letter from Major Charles S. Bromwell to Thomas A. Smyth, dated March 15, 1913, as follows:

"Engineer Office, United States Army,
509 Federal Building.
Chicago, Illinois, March 15, 1913.

Mr. Thomas A. Smyth,
President, Sanitary District of Chicago,
American Trust Building,
Chicago, Illinois.

Dear Sir:

"I am directed by the War Department to notify you that measurements made by the Engineer Department during February, 1913, indicate that since the Secretary of War's decision of January 8, 1913, you have been diverting from Lake Michigan more water than the 4,167 second feet authorized by the existing War Department permits.

"Your attention is invited to Section 10 of the Act of March 3, 1899, which is being violated by such diversion, also to the provisions of Sections 12 and 17, of the same Act, a marked copy of which is enclosed.

"Please advise this office what steps, if any, you propose to take to keep future diversions within the limits of the existing War Department permits and how soon such reduction of diversion may be expected.

"I have also to inform you that a continuation of the ex-

cess diversion may require action by the United States district attorney.

Very respectfully,
CHARLES S. BROMWELL,
Major, Corps of Engineers.

GWS
1 inclosure.
CHLR
140/236."

Letter from Edmund D. Adcock, Attorney for Sanitary District of Chicago, to Major Charles S. Bromwell, dated March 22, 1913:

"Je Mai Nt Iendrai
Lunion Fait Force

Mar 26 1913

Hotel Netherland
New York.

U. S. Engineer Office
Chicago, Ill.
March 22, 1913.

H. P. Whitaker, President.
George W. Swett, Manager.
Major Charles S. Bromwell,
Corps of Engineers, U. S. A.,
Federal Bldg., Chicago, Ill.

Dear Sir:

"I have before me your letters of February 24th and March 15th, 1913, respectively, addressed to Thomas A. Smith, President of the Board of Trustees of the Sanitary District of Chicago. Also a copy of the letter of President Smith to you dated February 27, 1913.

"The Board of Trustees took up for consideration your various communications and the subject matter therein referred to at a meeting of the Board held on March 11, 1913, and I was directed by resolution of the Board to reply to your letter of the 24th. However, on the morning of the 12th I was compelled to leave Chicago for New York where I have been since and am now engaged in the taking of testimony in the case of the United States of America versus The Sanitary District of Chicago. Hence, the delay in answering your letter.

"The suit above referred to was filed by the United States some time in the year 1908 in the District (then Circuit) Court of the United States for the Northern District of Illinois to enjoin the Sanitary District from constructing a channel known as the Sag Channel from the Calumet River to a

point on the main channel of the Sanitary District at Sag, and also to enjoin the District from reversing the flow of the Calumet River through the proposed new channel, and from taking the waters from Lake Michigan for the purpose of diluting the sewage of the Calumet District immediately south of the City of Chicago—in so far as such withdrawal might increase the amount of water that the Sanitary District had been theretofore authorized to take by the Secretary of War, etc., etc. This new channel is an adjunct to the main channel and is designed to serve the population of the Sanitary District in that portion of the district known as the Calumet region. One of the legal questions involved is, that the State of Illinois has the right to provide for the health of its citizens in the manner that it has; that the United States has not interfered and could not interfere with the right of the sovereign state to reasonably provide for the preservation of the lives and health of its citizens.

"The amount of water proposed to be diverted through the Sag Channel was approximately 4,000 cubic feet per second; that was at that time the capacity of the proposed channel. On June 30, 1910, while said suit was pending the Sanitary District was granted a permit by the Secretary of War to complete and construct the new channel and to reverse the flow of the Calumet River, and to take water from Lake Michigan through this new channel, provided, however, that the water that might be taken through the new channel and that taken through the main channel should not in the aggregate exceed the amount authorized by the Secretary of War. Upon the issuance of this permit of June 30, 1910, the Sanitary District entered upon the construction of the Sag Channel, and has up to the present time expended and contracted to expend upwards of several million dollars in its construction.

"You are no doubt aware that the International Waterways Commission by its report of 1907 recommended that no question be raised as to the right of the Sanitary District to flow through its channels for sanitary purposes at least 10,000 cubic feet of water per second, etc., etc. You are likewise probably aware that the Sanitary District under its Organic Act of 1889, commenced the construction of its channels through which it was to flow the waters of Lake Michigan for the purpose of diluting the sewage of the inhabitants of the Sanitary District; that on January 17, 1900, after approximately ten years devoted to construction work, and after the expenditure of many millions of dollars the main

channel of the Sanitary District was completed and the waters of Lake Michigan from that time on has flowed through the main channel into the Des Plaines River in quantities at most times sufficient to dilute the sewage in accordance with the specific provision of the Organic Act.

"Until the decision of the Honorable Secretary of War of January 8, 1913, it was the general belief that the Secretary of War would without question formally consent under present existing conditions to the taking of water up to at least 10,000 cubic feet per second from Lake Michigan through the channels of the Sanitary District.

"The Act under which the Sanitary District is organized and under which it is now operating makes it mandatory upon the Trustees of the Sanitary District to cause not less than 20,000 cubic feet of water per minute for each 100,000 of the population of the District to flow from Lake Michigan through its channels. The population of the District is such that to comply with its organic law, it is necessary that the Board of Trustees cause more than 4,167 cubic feet of water per second to flow through the channels of the Sanitary District. That condition has existed for a number of years past and the Sanitary District has been flowing through its channels sufficient water to dilute the sewage pursuant to its Organic Act (20,000 cubic feet per minute for each 100,000 of population). The Sanitary District cannot either under the law of its creation or if it intends to preserve the health of the inhabitants of the District reduce that flow.

"I have at some length pointed out to you the facts with most of which no doubt you are familiar so that the situation in which the Sanitary District is now placed may be fully considered by you.

"The Board of Trustees of the Sanitary District appreciate their responsibility in the matter. It is their desire that the rights of the Sanitary District be finally determined. With this in view, and inasmuch as the suit now pending relating to the Sag Channel involves issues which are somewhat similar to the questions now involved in the interrogatories propounded in your two letters, I respectfully suggest that the bill of complaint in the case of the United States vs. Sanitary District now pending be amended or a supplemental bill filed so that all the issues above referred to may be settled and promptly adjudicated. A great deal of testimony has been already taken, all of which will apply to the issues that would be raised by the proposed amended proceedings. A great deal of time, work and trouble would be saved

by pursuing the method I suggest and the Sanitary District will co-operate to speedily make up and try the issues upon the issues which may be presented by the amended or supplemental bill proposed, and will also stipulate that all testimony thus far taken, be treated as having been taken in the amended proceeding.

"I respectfully request that before any definite conclusion is reached by the Government with reference to these suggestions that a conference be arranged between the representatives of the Sanitary District and the Government at such time and place as may be convenient to the Government representatives.

Very respectfully,
EDMUND D. ADCOCK,
Attorney for the Sanitary District of Chicago."

Mr. Wilkerson: Referring to the notice served by counsel for defendant as to exhibits to be submitted on behalf of defendants, pursuant to stipulation of November 16, 1914, the United States reserves the right to specify such further documents or parts of documents as may be pertinent to any matters covered by subdivisions 3 and 4, of the paper entitled, "Memorandum of Documents to be referred to and exhibits to be submitted on behalf of defendants as further evidence in this case," served on counsel for the United States on December 6, 1914. This reservation is made because the time within which defendant is to specify particular documents has been extended by agreement until December 21, 1914, at which time the complainant is to present oral evidence concerning certain documents, in accordance with said stipulation of November 16, 1914.

Mr. Adcock: I offer in evidence on behalf of the defendant the following:

Extract from report of Mr. L. C. Sabin, July 1, 1900, Appendix III, Chief of Engineers, Report, Vol. 2, part 8, at p. 5401:

"The effect of withdrawing from Lake Michigan-Huron a certain amount of water through an independent outlet may now be determined within the limits of accuracy of our discharge equation. It has been said that the true discharge equation is probably of a higher degree than the first. A given change in stage at high levels would doubtless result in a greater change in discharge than at low levels. Consequently the continuous withdrawal of a fixed amount per second would effect a greater subsidence of lake level in low stages than in high stages. Considering the increment of discharge per foot rise in stage to be constant and equal to 19,030 cubic foot-seconds, the ultimate effect of withdrawing, say, 10,000 cubic foot-seconds, through an independent outlet will be to lower Lake Michigan-Huron 10,000÷19,030 or 0.525 foot, about 6¼ inches. If in very low water the increment of discharge becomes as low as 18,000 cubic foot-seconds the effect at low stage would be about 0.55 foot; and if at high stages the increment becomes as high as 22,000 cubic foot-seconds, the effect on the high stage would be 0.45 foot. When the lakes are below the mean stage of ultimate effect of the withdrawal of 10,000 cubic foot-seconds is probably not less than a half a foot.

"The area of Lake Michigan-Huron is, approximately, 45,314 square miles. A discharge of 10,000 cubic foot-seconds is equivalent to 0.0205 foot depth over the entire lake surface. The rate of fall, then, due to withdrawal of this amount of water alone would be 0.0205 foot per month, and to lower the lake 0.525 foot would require 25.6 months; but as soon as the lakes begin to fall on account of this additional discharge the discharge through the natural outlet will be diminished on account of the lower stage, and the rate of fall will thereby be diminished. The mathematical express of this law, giving the net change after months, is rather complicated and need not be given here. The results derived from it are given in the following table."

"Resolution Passed by the Forty-Fourth General Assembly, Special Session, 1906.

"Whereas, the Congress of the United States is now considering the report of the International Waterways Commission; and

"Whereas, said report contains a recommendation that the amount of water to be diverted from the Great Lakes through the Chicago Drainage Canal be limited to ten thousand (10,000) cubic feet per second; and

"Whereas, said limitation would in the future render futile the expenditure of fifty million ($50,000,000) dollars already expended by the Sanitary District of Chicago, and render impossible the completion of said project, and endanger the health of the people of Illinois and of the City of Chicago; and

"Whereas, the amount of water to be diverted for domestic and sanitary purposes should, under no circumstances, be limited by a treaty with a foreign power, or by any legislation to be enacted by Congress, thus placing the Sanitary District of Chicago—organized to preserve the health of the people—upon the same plane as commercial enterprises organized for private gain; now

"Therefore, be it resolved, by the Senate of the Forty-fourth General Assembly of the State of Illinois, convened in extraordinary session, the House of Representatives concurring therein, that in any treaty to be hereafter entered into, no statement whatever binding the trustees of the Sanitary District of Chicago shall be made, and the local conditions of such canal and the volume of water to be accommodated therein should be left wholly and solely to the regulation of the Federal Government, as the conditions of the canal's drainage may require; and

"Be It Further Resolved, that in any legislation to be hereafter enacted by Congress a provision should be included permitting the Sanitary District of Chicago to use such water as may be necessary in the discretion of the Secretary of War, and such legislation, if any, should be specifically provided that that portion of the report of the said International Waterways Commission referring to the Sanitary District of Chicago and the amount of water to be diverted through its channels should be entirely ignored; and

"Be It Further Resolved, that the two Senators and the members of Congress representing this state be and they are

hereby respectfully requested to do all in their power to incorporate the provision above referred to in any legislation to be passed by Congress, and prevent the incorporation of any statement in any treaty to be entered into with a foreign power placing any restriction upon the amount of water to be withdrawn through the Drainage Canal of the Sanitary District of Chicago; and

"Be It Further Resolved, that a copy of this resolution be forwarded immediately to the Secretary of State, to each Senator and Representative in Congress from this state, and to the President of the United States."

Mr. Adcock: I desire to offer in evidence all papers and documents offered for identification, or other documents, copies of which appear in the record, and not formally offered; and I desire that the documents which have been marked for identification, and bearing an identification number, may be considered as offered.

Mr. Wilkerson: If there happens to be any document which is offered, which is not copied in the record, it is understood you will give it to the Commissioner, so it will be printed. In other words, we want everything in the case in the printed record.

Mr. Adcock: I am not offering anything that does not now appear in the printed record. I simply make this offer in order to clear up any possible technicality as to whether the documents which were referred to by the witnesses and printed in the record, or identified by the witnesses, were not formally offered in evidence.

Mr. Wilkerson: There is not now in the record anything that is not printed, and that we have not used in our discussions of the case.

Mr. Adcock: No; everything is in the printed record now.

Saturday, December 19, 1914.
12:00 M.

Present:

Mr. Wilkerson, on behalf of the United States.
Mr. Adcock, on behalf of the Sanitary District.

The evidence of ISAAC DE YOUNG taken, so far as time is concerned, by stipulation today, instead of on last Wednesday.

ISAAC DE YOUNG, a witness called in rebuttal on behalf of the Government, was first duly sworn and testified as follows:

Direct Examination by Mr. Wilkerson.

Q. Please state your full name to the Commissioner?
A. Isaac DeYoung.
Q. Where do you live?
A. Sault Ste. Marie, Michigan.
Q. What is your occupation?
A. Civil engineer.
Q. In what service are you engaged?
A. U. S. War Department.
Q. Are you connected with the Lake Survey?
A. No.
Q. You are connected with what branch of the War Department; who is your immediate superior?
A. Engineer Department. My immediate superior is Mr. L. C. Sabin.
Q. How long have you been in the Government service?
A. Since 1901.
Q. What was your preparation before you went into the Government service, briefly?
A. Graduated from the Chicago Manual Training School and the University of Michigan.
Q. And you went directly after your graduation into the Government service?
A. No, sir, I was employed with the Big Four Railway about three or four months.
Q. And by any other companies?
A. Then from there, I was employed by the Michigan-Lake Superior Power Company, Sault Ste. Marie, Michigan.
Q. For how long?
A. 1898 to 1901.
Mr. Wilkerson: I will say that this evidence is directed to and is in connection with the Statistical Report of Lake Commerce for the season 1913, which is specified and offered in evidence.
Q. Referring specifically, Mr. DeYoung, to the canals at Sault Ste. Marie, have you had occasion recently to make any survey that has had to do with the Poe Lock?
A. Yes, sir.

Q. When was that survey made?
A. During November.
Q. 1914?
A. 1914.
Q. State generally what the nature of the survey was?
A. We had a diver cleaning off the sill preparatory to closing the locks, and while we had a diver down, we had him hold the sounding pole on the lower platform entering the lock; and we took several soundings on the sides and in the center of the lock; and the rod held was read by engineers' level.
Q. As to the elevation of the platform above the floor of the lock what did you find?
A. We found that on the sides the platform was not worn down from the passage of boats, but in the center it was worn slightly.
Q. How much?
A. Oh, I should judge about a half an inch.
Q. And as to the places which were not worn, as to their elevation above the floor, what did you find?
A. That was found to be the same elevation as the floor of the lock.
Q. And in the middle, it was worn down about half an inch?
A. About half an inch.
Q. Just where is that platform with reference to the floor of the lock?
A. The platform is partly outside of the masonry, the lower end of the masonry of the lock. It is separated by the two surface gates, lower surface gates.
Q. Is the platform below the lower guard gate?
A. It is.
Q. It is the only platform there is in that particular vicinity?
A. Yes, sir.

Cross-Examination by Mr. Adcock.

Q. What is your title there, Mr. DeYoung?
A. U. S. Assistant Engineer.
Q. What are your duties?
A. My duties have been designing lock gates and immediate charge of construction of the east approach to the locks, —dredging.

Q. Entirely engineering matters?
A. Entirely engineering.
Q. You were not connected with the War Department, at the time the Poe Lock was built?
A. No, sir.
Q. Do you have anything to do with the operation of the lock, directly?
A. Operating, and care only in connection with repairs.
Q. The operation of the lock and the passing of boats through the lock and so forth, that is done by somebody else besides you, isn't it?
A. Yes, sir.
Q. Did you make these soundings personally?
A. No, sir; under my immediate supervision.
Q. Were you present when the—
A. No, sir.
Q. Who did make the soundings?
A. Inspector Owen Frederick.
Q. Did you make any examination of the notes, field notes, that were made by the engineers who made this survey?
A. I examined them after they were made.
Q. You were not present at all when that was done?
A. No, sir.
Q. Do you know the elevation of the top of this platform that you speak of, as compared with the elevation of the top of the lower miter sill of the Poe Lock?
A. I don't think I do. I think, however, it is the same elevation.
Q. That is only an opinion that you have?
A. Yes.
Q. You don't know anything about it?
A. No, sir.
Q. Did you ever examine the plans under which the Poe Lock was built, particularly referring to this platform?
A. I have examined them, not particularly. I may say here that the plans are not very complete that we have in the office, in connection with the Poe Lock.
Q. So you never made any examination of those plans to determine the elevation of the top of this platform as compared with the elevation of the top of the lower miter sill of the Poe Lock as shown by those plans,—construction plans?
A. I have examined the plans in that connection but I don't remember exactly what I saw. The plans are very—they show—

Mr. Adcock: I move to strike out what they show. Don't say what they show. I want to get what you know.

A. What is the question again?

Q. (Last question read to the witness.)

A. I have examined those plans, but I don't remember now the relative elevations.

Q. Did you receive any instructions from anyone with reference to making a survey of the lock there; that is before the survey was made?

A. No, sir, only to make the survey.

Q. From whom did you receive that instruction?

A. Mr. L. C. Sabin.

Q. What did he say about it, did he write you a letter?

A. No, sir.

Q. Just told you that?

A. His method of giving instructions is by scrap notes.

Q. Did he say why he wished you to make the survey?

A. No, sir.

Q. What time in November did you make the survey?

A. I don't remember.

Q. What day?

A. I don't remember the date.

Q. Was it before or after the 16th of November?

A. I think it was after the 16th.

Q. Do you know how long?

A. Perhaps I might refresh my recollection.

Q. You know Thanksgiving day was about the 24th?

A. Yes.

Q. Was it after Thanksgiving?

A. It was before Thanksgiving, I am pretty sure.

Q. It was before, two or three days before? It was between the 16th and Thanksgiving day?

A. As far as I remember, yes, sir.

Q. You were first assistant to Mr. Sabin from 1900, were you?

A. No, sir.

Q. You never knew of a survey of this kind being made before, did you?

A. Yes, I do. There was a survey made of the east approach to the lock, taking 10 by 10 soundings, and the soundings extended up into the lock. These were rough, from water surface levels.

Q. Only?

A. Yes.

Q. So you would not obtain very accurate results in that way?

A. They could be taken within one-tenth of a foot.

Q. Did you make those soundings?

A. No, sir.

Q. Did you ever examine the notes of those soundings?

A. No, sir.

Q. When were they made?

A. I think they were made in 1904.

Re-direct Examination by Mr. Wilkerson.

Q. Is the miter sill the same elevation as the floor of the lock?

A. I think it is.

Q. Mr. DeYoung, I understood you to say you were in immediate charge of the survey?

A. Yes, sir.

Q. The work was done by engineers who worked under your direction?

A. Yes, sir.

Q. You took their reports?

A. Yes, sir.

Q. And from the reports made to you in this regular course of business, you make your statement that the platform is not elevated above the floor?

A. Yes.

Q. That is right, is it?

A. Yes, sir.

Re-cross Examination by Mr. Adcock.

Q. You were not present when the soundings were made or the survey was made?

A. No, sir.

Further Re-direct Examination by Mr. Wilkerson.

Q. When you say you were not present, you mean you were not actually on the ground?

A. I was not right there at the level.

Q. Where were you?

A. I was in the office.
Q. These men reporting to you right along?
A. I examined the notes.
Mr. Adcock: After the survey was made.
A. You probably understand how it is done.
Mr. Wilkerson: Describe how it is done so that we will get it into the record.
A. The level being set up, you read the bench mark of which we know the elevation, and then we read on the rod which shows the elevation of the bottom of the rod. If I had been right there at the level I would not have known any more about the accuracy of it than I would have if I had been right there in the office, not taking the notes.
Mr. Adcock: Q. How many men were there engaged in making this survey to determine the elevations,
A. There was the diver, the instrument man and the rod reader.
Mr. Wilkerson: We reserve the right at any future time to have the plans to which Mr. Ripley referred incorporated into the record.
Mr. Adcock: Q. How long ago did you make an examination of the notes of the survey of 1904?
A. I had the plans out some time during the last month.
Q. The last month?
A. Yes.
Mr. Wilkerson: Q. This platform has not been rebuilt since you have been there, has it?
A. No, sir.
Mr. Wilkerson: That is all.
Mr. Adcock: That is all.

TABLE SUBMITTED BY DEFENDANT SHOWING EXPENDITURES ANNUALLY FROM 1890—1912 INCLUSIVE, ETC.

EXPENDITURES BY THE SANITARY DISTRICT OF CHICAGO.
Cost of Works for Sanitation up to Dec. 31, 1912.

1890	$ 67,963.38	
1891	144,870.36	
1892	930,481.45	
1893	3,631,674.03	
1894	5,909,921.93	
1895	6,764,139.03	
1896	5,043,878.02	
1897	3,196,592.00	
1898	1,876,635.20	
1899	3,967,358.40	
1900	2,618,141.25	
1901	1,225,683.07	
1902	2,007,410.62	
1903	2,011,672.37	
1904	1,635,314.50	
1905	2,770,053.56	
1906	1,568,251.22	
1907	1,931,703.70	
1908	1,268,502.27	
1909	2,044,755.68	
1910	2,396,700.65	
1911	830,554.38	
1912	544,418.86	
		$54,441,676.00
Estimated cost in 1913 and 1914, to complete works 10,000 C. F. P. S.		2,249,243.61
Main channel extension and Water Power Act		5,463,702.64
Calumet-Sag Channel		555,961.39
Miscellaneous		22,337.10
Administration other than Sanitation, 1890-1913		796,102.11
Maintenance and operation		1,660,024.61
City of Chicago Contract, Oct. 27, 1910		1,638,053.62
Expended by City of Chicago Intercepting sewers, pumping stations, etc., 1880-1907		7,404,162.74
Fixed Charges		10,521,484.26
Grand total		$84,802,748.17